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REPORT
ON
THE L FEASIBILITY OF USING THE CITY HALL
PLANT FACILITIES FOR HEATING
AND COOLING REQUIREMENTS OF THE
THEATRE AUDITORIUM



AMENDMENT TO
REPORT ON
THE FEASIBILITY OF USING THE CITY HALL
PLANT FACILITIES FOR HEATING
AND COOLING REQUIREMENTS OF THE
THEATRE-AUDITORIUM

In view of more recent information received from Department of Energy and Resources Management, Air Management Branch, with regard to stack heights for compliance with air pollution requirements, we must alter the recommendations given in our report of March 6, 1970.

In order to keep ground level concentrations and impingement concentrations of sulphur dioxide and nitrogen oxides at an acceptable level, the existing stacks must be increased to heights indicated in the following table.

<u>Fuel</u>	<u>Required Stack Height Above Grade</u>	
	<u>Existing Plant</u>	<u>Combined Plant</u>
Natural Gas	10 to 16 Feet	40 Feet
No. 2 Fuel Oil	30 Feet	300 Feet
No. 6 Fuel Oil	300 Feet	320 Feet
(Refer to Page 9 of Summary)		

Stack diameters must also be reduced or cones provided to increase minimum exit velocities to 25-30 feet/second.

It should be noted that requirements for natural gas are based on a firm gas contract, without No. 2 oil standby. If an interruptable gas contract with No. 2 oil standby be considered then stack requirements for No. 2 fuel oil will apply.

It should also be noted that stacks for natural gas can be type "B", a double wall metal stack of reasonable weight, which can be mounted in a free standing arrangement without too much difficulty.

However, stacks suitable for oil must be type "A", refractory lined metal or masonry, which are extremely heavy and require new foundations. In addition, the stack diameters required for this

particular installation make it virtually impossible to provide a free standing arrangement, without the use of guy wires, of stacks exceeding 30 feet above grade.

Our original recommendations as stated, remain the same, except boilers should be fired with natural gas only, purchased on a firm contract basis.

Revised Costs

Section A

The cost of providing new boilers will increase by virtue of the higher stacks required and subsequently a more complicated bracing system. It is estimated this work will add \$13,000.00 to the original estimate.

Fuel operating expenses will be higher than originally estimated, due to necessity of a firm gas contract instead of an interruptable contract. Average rate for a combined plant is estimated at \$0.83 per thousand cubic feet (M. C. F.).

Therefore, the following revised estimated costs are presented.

Total Cost of New Combined Heating Facilities (Refer to Page 5 of Summary)

New Low Pressure Steam Boilers	\$147,000.00
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Theatre-Auditorium Hot Water System and Connections	<u>209,000.00</u>
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Total Cost	<u>\$356,000.00</u>
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Cost Comparison - Combined Heating Plant

VS Separate Heating Plants

(Refer to Page 5 of Summary)

In order to make cost comparison truly relative, price estimate for separate City Hall plant is based on new boilers. The estimate for separate Theatre-Auditorium plant includes allowance of \$20,000.00 for provision of building space and chimney.

Total Cost Combined Plant	\$356,000.00
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* Separate City Hall Plant -	\$ 68,000.00
Separate Theatre-Auditorium Plant	<u>-106,000.00</u>

\$174,000.00

Extra Cost for Combined Plant	<u>\$182,000.00</u>
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- * The cost of recommended method of modifying the existing City Hall plant to comply with air pollution control requirements.

Operating Costs - Heating (Refer to Pages 5 and 6 of Summary)

Separate Plant Costs - Annual

City Hall Plant

Staff wages, benefits	\$ 68,000.00
Fuel - 40,000 M. C. F. (actual)	34,000.00
Power, repairs, etc. (estimated)	<u>4,200.00</u>
	\$106,200.00

Theatre-Auditorium Plant

Staff wages, benefits	\$ 68,000.00
Fuel - 30,000 M. C. F. (estimated)	25,500.00
Power, repairs, etc. (estimated)	<u>4,200.00</u>
	\$ 97,700.00
	<u>\$203,900.00</u>

Combined Plant Costs - Annual

Staff wages, benefits	\$ 78,000.00
Fuel - 70,000 M. C. F. (estimated)	58,100.00
Power, repairs, etc. (estimated)	<u>8,400.00</u>
	\$144,500.00

Combined Plant Saving - Annual \$ 59,400.00

On the basis of the above operating expenses, the average cost of steam produced is as follows:

Separate Plant -	\$3.90 per 1000 lbs.
Combined Plant -	\$2.80 per 1000 lbs.

Preliminary published data for proposed central steam plant indicates an average purchase cost of \$2.50 per 1000 lbs. for the first 1,000,000 lbs. per month.

Section B

All estimated costs indicated in original report remain unchanged, except rental of conversion gas burners will reduce to approximately \$250.00 per month.

Comments on Air Pollution Regulations

It should be noted that air pollution regulations call for maximum allowable ground level and impingement concentrations of pollutants; sulphur dioxide in the case of fuel oil, and nitrogen oxides in the case of natural gas.

All indicated stack height requirements are approximate, based on accepted engineering standards for various fuels, input levels and dispersion factors.

Application for Department of Energy and Resources Management approval of heating plant modifications will indicate the exact capacity of boilers or burners, type of fuel to be used, height and size of stacks to be installed. A site plan must also be submitted, indicating all adjacent buildings with heights above grade, within a given radius of the stack locations.

Departmental approval of the proposed installation on the basis of this information is not necessarily final. Only after the modified plant is in full operation, and satisfactory tests completed, will final approval be granted.

In essence, the regulations are basically a performance requirement, the onus being on the Owner to maintain pollution concentrations within the maximum allowable level.

REPORT
ON
THE FEASIBILITY OF USING THE CITY HALL
PLANT FACILITIES FOR HEATING
AND COOLING REQUIREMENTS OF THE
THEATRE-AUDITORIUM

TO
THE CORPORATION OF THE CITY OF HAMILTON
71 MAIN STREET WEST
HAMILTON, ONTARIO

MARCH 6, 1970

CONSULTANTS

QUIST & ASSOCIATES LIMITED
Consulting Professional Engineers
918 Main Street East
Hamilton 22, Ontario

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INTRODUCTION

The Corporation of the City of Hamilton engaged the services of Quist & Associates Limited to carry out an investigation and prepare a report on the feasibility of obtaining heating and cooling services for the Theatre-Auditorium building from the existing City Hall plant facilities.

We, in turn, have sought the advice of Keith Associates Limited, Toronto, with whom we are associated with respect to the Theatre-Auditorium project.

The scope of work given to us is as outlined below:

- 1.) Determine the output of present City Hall heating plant if converted to natural gas firing.
- 2.) Determine condition of existing water tube boilers, and cost of refurbishing, in order to comply with item (1.).
- 3.) Compare cost of new boilers against costs of items (1.) and (2.) above.
- 4.) Cost of additional new boilers in the City Hall plant to serve Theatre-Auditorium.
- 5.) Cost of increasing chiller, cooling tower and allied pump capacities in the City Hall plant, to serve Theatre-Auditorium.
- 6.) Determine the cost of routing heating and cooling piping services from the City Hall to Theatre-Auditorium.
- 7.) In association with the City Architect, determine cost of altering the existing plant building.
- 8.) Determine modifications and associated costs of altering existing stacks, to comply with air pollution control requirements.
- 9.) Determine total operating costs of modified City Hall plant and compare with total operating costs of a separate in-house plant in the Theatre-Auditorium.

The scope of work was slightly altered by a request from Mr. Monaghan to report on the necessary actions required to deal with the present smoke pollution from the City Hall plant, which led us to divide the report into two distinct sections; Section "A" being "Study of City Hall Plant with Respect to the Feasibility of Obtaining Heating and Cooling from this Plant for the Theatre-Auditorium", and Section "B" being "Study of City Hall Boiler Plant with Respect to the Necessary Actions Required to Deal with the Present Air Pollution Problem"; so that the two problems can be described and assessed strictly on their own.

Since the present air pollution problem would be affected by the proposed use of the plant for the Theatre-Auditorium, it is only natural that we should cover this aspect during the course of our study. Therefore, Section "B" deals with the various changes that could be made to the existing plant in the event that it remains basically the present capacity, serving City Hall only.

During the course of the investigation, the following contributed to the information obtained:

- 1.) The City of Hamilton, Office of Civic Square Development
(Mr. R. C. Monaghan, Co-ordinator)
- 2.) The City of Hamilton, Office of City Architect
(Mr. A. K. German, City Architect)
- 3.) The City of Hamilton, Boiler Plant
(Messrs. Convey and Constantinides)
- 4.) The Ontario Department of Energy and Resources Management, Air Management Branch, Hamilton
(Mr. J. Chrystman, District Engineer)
- 5.) United Gas Limited, Hamilton
(Mr. Matt Blair, Commercial Sales Supervisor)
- 6.) Trane Company of Canada Limited, Hamilton
(Mr. P. A. Loucks)
- 7.) Fuel Applications Limited, Hamilton
(Mr. R. Zabrok)
- 8.) Numerous suppliers, contractors and others, whose quotations, submissions, etc., were of inestimable assistance to us.

SUMMARY

SECTION A - PROVIDING HEATING AND COOLING FROM CITY HALL PLANT FACILITIES FOR THEATRE-AUDITORIUM REQUIREMENTS

We hereby present a brief summary of the major items covered in the report, together with conclusions and recommendations.

1.) Cost of Additional New Boilers in City Hall Plant to Serve Theatre-Auditorium

In order to serve the Theatre-Auditorium heating requirements, it would be necessary to modify the present City Hall boiler plant as follows:

Remove existing water tube boilers No. 1 and No. 2.
(These boilers cannot be increased sufficiently in capacity)

Install two 500 HP packaged fire-tube boilers, each capable of producing 17,000 Lbs/Hr. low pressure steam.

Estimated cost of supplying and installing the larger new boilers is One Hundred Thirty-Four Thousand Dollars (\$134,000.00).

2.) Cost of Routing Heating Services from City Hall to Theatre-Auditorium

Considerable study of providing underground piping services between the two buildings indicates that transmitting low pressure steam is impractical.

Therefore, it is recommended that hot water be generated in City Hall and piped in a closed loop to Theatre-Auditorium. Insufficient available space does not permit location of heat exchangers and circulating pumps in boiler room. It is proposed to locate this equipment in the basement apparatus room in City Hall, routing steam and condensate piping through existing tunnel from the boiler room.

Two 8" diameter pipe mains would supply and return hot water to and from Theatre-Auditorium, following a route approximately as shown on drawing A3. The underground portion of the pipe mains would be installed using the Ric-Well or similar method, which consists of the two insulated pipe mains being enclosed in a single 24" diameter galvanized steel conduit, completely sealed and protected with an epoxy coating.

Estimated cost of supplying and installing piping, pumps and exchangers - Two Hundred and Nine Thousand Dollars (\$209,000.00).

3.) Total Cost of New Combined Heating Facilities

New Low Pressure Steam Boilers	\$134,000.00
Theatre-Auditorium Hot Water System and Connections	<u>209,000.00</u>
Total Cost	<u>\$343,000.00</u>

4.) Cost Comparison - Combined Heating Plant
VS Separate Heating Plants

In order to make cost comparison truly relative, price estimate for separate City Hall plant is based on new boilers. The estimate for separate Theatre-Auditorium plant includes allowance of \$20,000.00 for provision of building space and chimney.

Total Cost Combined Plant	\$343,000.00
* Separate City Hall Plant -	\$ 68,000.00
Separate Theatre-Auditorium Plant -	<u>106,000.00</u>
	<u>\$174,000.00</u>
Extra Cost for Combined Plant	<u>\$169,000.00</u>

5.) Operating Costs - Heating

A combined plant can be operated by the same number of stationary engineers as presently operate the existing plant, whereas separate plants require duplicate staff.

A combined plant would make it possible to purchase natural gas on an interruptable contract at an average rate of \$.60 per M. C. F. Separate plants would not have sufficient individual consumption to qualify for this type of contract and average cost of gas would be \$.85 per M. C. F.

- * The cost of recommended method of modifying the existing City Hall plant to comply with air pollution control requirements.

Separate Plant Costs - Annual

City Hall Plant

Staff wages, benefits	\$ 68,000.00
Fuel - 40,000 M. C. F. (actual)	34,000.00
Power, repairs, etc. (estimated)	<u>4,200.00</u>
	\$106,200.00

Theatre-Auditorium Plant

Staff wages, benefits	\$ 68,000.00
Fuel - 30,000 M. C. F. (estimated)	25,500.00
Power, repairs, etc. (estimated)	<u>4,200.00</u>
	\$ 97,700.00
	\$203,900.00

Combined Plant Costs - Annual

Staff wages, benefits	\$ 78,000.00
Fuel - 70,000 M. C. F. (estimated)	42,000.00
Power, repairs, etc. (estimated)	<u>8,400.00</u>
	\$128,400.00

Combined Plant Saving - Annual

On the basis of the above operating expenses, the average cost of steam produced is as follows:

Separate Plant - \$3.90 per 1000 lbs.
Combined Plant - \$2.50 per 1000 lbs.

Preliminary published data for proposed central steam plant indicates an average purchase cost of \$2.50 per 1000 lbs. for the first 1,000,000 lbs. per month.

6.) Provision of Cooling Services for Theatre-Auditorium from City Hall Plant

Theatre-Auditorium cooling requirements have been estimated at approximately 450 tons. The City Hall plant has an available excess capacity of almost 300 tons.

Immediately it would seem reasonable to utilize the spare capacity augmented by a 150 ton chiller, to serve the Theatre-Auditorium.

However, a detailed study of the water flow arrangement in the existing plant indicated problems would be encountered, particularly with the addition of a third chiller, in maintaining 42 deg. F. chilled water supply temperature during low demand periods with one chiller operating.

A method of flow control was devised, involving a third chiller of equal capacity to existing units, with changes to existing units as well. However, the present refrigeration room floor space and headroom would not accommodate the arrangement. A preliminary cost study of the equipment and building changes, together with piping services to the Theatre-Auditorium indicated a completely uneconomical situation.

Conclusions

Heating

Combined plant capital cost exceeds separate plant costs by \$169,000.00. However, the annual saving in operating expense with a combined plant dictates no other consideration, unless central plant steam will be available in the near future.

Cooling

Cooling from City Hall plant not economical.

Recommendations

Heating

Unless central plant steam will be available in the near future (2 - 3 years), it is recommended that a combined heating plant be installed in City Hall, to serve the Theatre-Auditorium.

Cooling

Provision of cooling for the Theatre-Auditorium from the City Hall plant should not be considered.

Unless central plant chilled water will be available in the near future, it is recommended that a separate chilled water plant be provided in the Theatre-Auditorium building.

Note Re Estimated Costs

All estimated costs indicated in this report are based on current material, labour and tax rates and may escalate depending on time of tendering and/or installation.

All prices include Federal Sales Tax only. Provincial Sales Tax extra.

SUMMARYSECTION B - MODIFICATIONS TO EXISTING CITY HALL BOILER PLANT
TO COMPLY WITH AIR POLLUTION REQUIREMENTS1.) Modifications to Existing Stacks

Existing stacks must be increased in height to comply with air pollution requirements.

<u>Fuel</u>	<u>Required Stack Height Above Grade</u>	
	<u>Existing Plant</u>	<u>Combined Plant</u>
Nat. Gas/No. 2 Oil Standby	16 Feet	22 Feet
No. 2 Fuel Oil	36 Feet	48 Feet
No. 6 Fuel Oil	75 Feet *	115 Feet *

* Indicated stack heights suitable only for elimination of ground level pollution. Impingement against taller adjacent buildings could increase heights considerably.

Modifications for natural gas firing most economical. All estimated costs for the various proposed boiler plant alteration schemes include stack modifications to suit natural gas.

2.) Output of Present City Hall Heating Plant Converted
to Natural Gas Firing

Water Tube Boiler #1 -	6900 lb/hr.
Water Tube Boiler #2 -	6900 lb/hr.
Fire Tube Boiler #4 -	4300 lb/hr.
Total Output	18100 lb/hr.

Water tube boilers # 1 and # 2 are, at present, only suitable for oil firing. Boiler #4 is equipped for dual gas-oil firing, but requires some additional control to update to present code requirements.

A cost of \$26,000.00 has been estimated to convert boilers #1 and #2, and update boiler #4. All boilers would be suitable for dual firing with natural gas, with No. 2 fuel oil as emergency standby.

Alterations to existing stacks as required by Air Pollution Control are included in this estimated cost.

An alternative rental proposition on conversion burners has been submitted by United Gas Limited for boilers # 1 and # 2, at a

total installed rental price of \$275.75 per month. This does not include updating boiler #4, or alterations to existing stacks. It is suggested that an allowance of \$8,000.00 be considered for this work.

3.) Condition of Existing Water Tube Boilers

Both boilers were in operation at the time of our inspection, and weather conditions did not permit shutdown for a detailed internal investigation. However, a visual inspection means very little unless sample tube sections are removed and wall thickness measured.

Mr. Convey, the Chief Engineer, has kept accurate records of tube replacement, and visual observation of tube sections recently replaced, indicates severe corrosion.

It is our opinion that complete tube replacement is necessary if it is intended to continue using the boilers in a long range program. A budget estimate for retubing was obtained by Mr. Convey in May, 1969, from the boiler manufacturer, Canadian Vickers Limited, indicating a cost of \$16,000.00 per boiler.

4.) Cost Comparison - New Boilers VS Conversion and Repair of Existing Water Tube Boilers

New Boilers

If new boilers are considered, we recommend installing two 200 HP packaged low pressure steam boilers with dual firing Gas-No. 2 fuel oil, each capable of producing 6900 lbs/hr. steam.

Cost Comparison

1.)	<u>New Boilers</u> - completely installed, including removal of existing water tube boilers, conversion of existing fire tube boiler #4, and alterations to existing stacks	<u>\$68,000.00</u>
2.)	<u>Conversion and Repair - Existing Boilers</u> - conversion to gas-oil firing and alterations to existing stacks	<u>\$26,000.00</u>
	Re-tubing water tube boilers	<u>32,000.00</u>

\$58,000.00

Conclusions

Existing Stacks

The required modifications on the basis of using natural gas are the most economical to accomplish, and present no esthetic problems. Stacks suitable for No. 2 fuel oil are too costly to consider, especially since there is no advantage in fuel costs compared to gas. Refer to Article B7 on page B-7.

Conversion of Existing Boilers VS New Boilers

On the basis of a long range program, re-tubing of the present watertube boilers must be considered. The cost of this work combined with the cost of burner conversion is estimated at only \$10,000.00 less than the installed cost of two new fire tube boilers.

Recommendations

Stacks

Natural gas with No. 2 fuel oil standby is the recommended fuel, to provide the most economical stack modification.

Boilers

In spite of the higher capital cost, we recommend installing new boilers in lieu of converting and repairing existing water tube boilers. New boilers will provide higher operating efficiency, longer trouble free service, and more economical tube replacement.

However, if central plant steam facilities will be available for the Civic Square area within the next two to three years, it is recommended that the City Hall be connected to such facilities. In this case, the most economical interim measures should be considered, namely, rental conversion burners, with patchwork retubing as required to maintain existing boilers.

Note Re Estimated Costs

All estimated costs indicated in this report are based on current material, labour and tax rates and may escalate depending on time of tendering and/or installation.

All prices include Federal Sales Tax only. Provincial Sales Tax extra.

SECTION A - STUDY OF CITY HALL BOILER PLANT WITH RESPECT TO
 THE FEASIBILITY OF OBTAINING HEATING AND COOLING
 FROM THIS PLANT FOR THE THEATRE-AUDITORIUM

SECTION A1 - DESCRIPTION OF EXISTING PLANT AND COMMENTS

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SECTION A1

DESCRIPTION OF EXISTING PLANT AND COMMENTS

GENERAL: The existing plant is located in the east end of the garage-boiler plant complex, which is situated to the south of the City Hall proper.

A tunnel connects the boiler house with the basement of the City Hall and terminates in the large apparatus room, which takes up the south area of the basement. (East and West Apparatus Rooms)

The boiler plant consists of three distinct areas. The south half of the building, which is basically two floors high, houses the boilers and ancillaries, air compressor, emergency generator, and hydro-pneumatic tank. The north half of the building has two individual floor levels. The lower level contains the refrigeration plant, while the upper level contains electrical room, Chief Engineer's office, store room, staff change room, etc.

The plant is approximately ten (10) years old and appears to be well maintained and well constructed.

A1-1 HEATING

Heating energy is being produced in the form of 12 psig saturated steam, which is produced by three low pressure boilers fired with No. 6 fuel oil. Steam is distributed from the plant to the City Hall and to the garage complex for heating, and condensate is returned to the plant for recycling through the system. Steam is produced all year round for domestic water heating and terminal reheating for some air-conditioning systems.

A1-1-1 BOILERS

Boilers #1 and #2 are large water-tube boilers normally used during the heating season, supplemented by a smaller fire-tube package boiler, #4, which is also used during the off-heating season when the steam demand is reduced.

The water-tube boilers, boilers 1 and 2, were designed to have a nominal capacity rating of 125 HP or 4300 lb/hr but were to be capable of being operated at 150 percent of rated capacity or an output of 185 HP, which would be 6400 lbs/hr. The boilers have actually been fired at 6200-6500 lbs/hour, but for air pollution reasons, the output is limited to 5500 lb/hour when fired with No. 6 fuel oil. These boilers do not have any provision for gas firing.

The fire-tube boiler, #4, has a maximum output of 4300 lb/hr. and has been designed for gas-oil operation, but is presently not connected to gas.

Boiler #3 is the designation for a future water-tube boiler of similar construction to boilers #1 and #2.

A1-1-2 CONDITION OF BOILERS

It appears that the boilers have been fired since start-up with grade No. 6 fuel oil, which is derived from a sour Canadian crude oil and which has a high content of sulfur.

Combustion of this oil frees sulfur to form sulfur dioxide (SO_2) which will dissolve in water to form sulfurous acid (H_2SO_3) on oxydation with free oxygen, (available through leaking seals of the panels) or during a down period it will form sulfuric acid (H_2SO_4), which in turn will react chemically with the steel watertubes, stacks and walls of the boilers, causing corrosion of the tubing, etc.

This process will be aggravated if boilers are subject to load cycling and associated heat cycling as is the case in a heating plant of this nature.

I. E. - Cooling down of the boilers would create condensing of water - vapour (which is ever present as a product of combustion) or pipe leakage (seepage) through pin holes or leaking tube joints into mud or steam drums.

Severe corrosion has been observed over the years during operation and inspection, but it is not really possible to judge the actual condition of the tubes until sample sections are removed and wall thicknesses of the samples are measured.

Some tube replacement has taken place and the status of this is briefly as follows:

Boiler #1

Only a few sidewall tubes have been replaced.

Boiler #2

All of the side wall tubes in the number two boiler have been replaced, a few of them for the second time. Only two on the rear tube bundle have been replaced.

Boiler #4

All tubes have been replaced.

Replacing tubes in a water-tube boiler is a very cumbersome and expensive process, this probably being the reason of diminished popularity of this type of boiler for small plant applications.

It is without a doubt, that boilers #1 and #2 will need to be retubed in the near future judging by tube samples inspected, visual observation and reports received from the operating staff.

Budget estimates for complete retubing were obtained by Mr. Convey in 1969 from Canadian Vickers which showed that it would cost approximately \$16,000.00 per boiler to do this work, including resetting of the interior masonry walls. See exhibit A1.

It is useful to point out here that the plant has no spare capacity during severe cold weather and a breakdown of one of the large boilers would leave the Hall short of heating capacity.

City Hall - Normal Demand	9,000 lb/hr.
Peak Demand	11,000 lb/hr.

Boiler #1 capable to deliver	5,500 lb/hr.
" #2 "	5,500 lb/hr.
" #4 "	<u>4,300 lb/hr.</u>

Total Available	15,300 lb/hr.
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A1-1-3 BOILER CONTROL PANEL

Boilers 1, 2 and 4 are connected to a boiler control panel on which a number of meters, recorders and controls are accumulated to provide remote metering and control of the following parameters.

Metering

- 1.) Furnace pressure
- 2.) Wind box pressure
- 3.) CO₂ content indicator

Control

- 1.) Air - fuel ratio (Boilers #1 and #2 only)

Recording

- 1.) Steam header pressure
- 2.) Steam flow for each boiler
- 3.) Air flow
- 4.) Flue gas temperature

A1-1-4 CONDENSATE SYSTEM

The condensate system consists of a condensate receiver tank with provision for water make-up. The tank has a capacity of 460 Imp. gallons.

Condensate is returned from remote points by condensate pumps.

Three boiler feed pumps, one for each boiler, feed condensate and make-up water back into the boilers as demanded by a level switch mounted on the boiler steam drums.

The following pumps are installed each connected to its associated boiler with no provision for stand-by or cross connections, in other words, if one feed pump fails, its associated boiler would be shut down.

Condensate Pumps

#1 Boiler - Alco type 1CAD, Serial #65215, RPM 3500.
 Head Pressure: 59 Hd. Ft.
 Capacity: 20 US GPM

#2 Boiler - Same as #1.

#4 Boiler - Alco type 1CAD, Serial #65214, RPM 3500.
 Head Pressure: 59 Hd. Ft.
 Capacity: 12 US GPM

A1-1-5 FUEL OIL SYSTEM

The fuel oil system consists of two buried 12,000 Imp. gallon storage tanks installed underground to the north of the boiler house.

A complete recirculating fuel oil pumping system is installed with pipeline heating, recirculating heaters, etc.

The system has two transfer pumps, each capable of handling 400 US GPH #6 oil at 30 psi discharge pressure.

The pump sets are located along the north wall of the refrigeration room and the system appears to be in good condition.

A1-1-6 CHEMICAL FEED SYSTEM

The existing chemical feed system appears to be satisfactory for the present plant and no changes are contemplated.

A1-1-7 FLUE GAS STACKS

There is one flue gas stack for each boiler and provision for a fourth stack for the future boiler. The stacks are made of 3/16 black steel sheeting and although they appear to be in good condition, it may be possible that there has been corrosion due to the presence of sulfur. The stacks extend approximately 10'0" above the upper parking lot.

On the basis of using natural gas as the primary fuel, with No. 2 fuel oil as a standby, we have been advised by Department of Energy and Resources Management, Air Management Branch, that stack heights must be increased. Preliminary data received from them indicates the following:

- 1.) Retaining existing plant capacity will require six (6) foot extension to all existing stacks, resulting in a total height of 16 feet.
- 2.) If plant output is increased to provide heating for both City Hall and the Theatre-Auditorium, all existing stacks must be extended 12 feet to a total height of 22 feet.

See exhibit A2.

A1-1-8 AVAILABILITY OF NATURAL GAS AND GAS CONTRACTS

A 4" gas main enters the plant from the east and reduces to a 1" meter and regulator set just under the stairway at the east entrance. Gas is only used at present for ignition purposes of the boilers, i. e. pilot flames.

However, the United Gas Limited advises that ample service is available for natural gas firing of existing boilers or new boilers of capacity to serve both City Hall and Theatre-Auditorium.

There are two types of contracts available; the first type is a firm uninterrupted contract where gas would be supplied at all times. The average rate for this type of contract is \$. 85 per 1000 Cu. Ft.

The second type is an interruptable contract, which means that gas service may be shut off under extreme emergency conditions, such as low pressure in mains. The contract is only available when annual consumption exceeds 45,000,000 C. F. The rate under this contract is approximately \$. 60 per 1000 Cu. Ft.

The existing plant would not exceed 40,000,000 C. F. based on past annual oil consumption figures, and hence, the interruptable contract would not be available. However, if plant capacity were increased to handle the Theatre-Auditorium, annual gas consumption would be considerably above the minimum requirements for interruptable service.

A1-1-9 SOOT BLOWER SYSTEM

A soot blower system for the boilers is in existence, which consists of an air compressor, air receiver and the necessary piping.

A1-2 COOLING

The existing system consists of two 325 ton centrifugal type refrigeration machines, manufactured by Trane, operating in parallel, with two chilled water pumps for circulation of chilled water to the systems in the City Hall.

The condenser cooling water system consists of two condenser water pumps and a cooling tower, located on the roof of the plant, i. e. on the level of the upper parking lot.

One machine provides sufficient cooling capacity for most of the cooling season, and the second machine has been called upon only about 10 times during the past ten years.

A1-2-1 REFRIGERATION MACHINES

Trane Centra-Vac Model # H5X-51C-54B with 280 Amp.
60/3/550V 3600 RPM motor.

Evap.	Velocity in tubes	6.51 FPS
Cond.	" " "	6.14 FPS

Evaporator 3 Pass -	Combination 36
Condenser 2 Pass -	Combination 50

Design capacity 325 tons to chill 685 GPM of water from 53.4 deg. F. to 42 deg. F. when supplied with 975 GPM of condenser water entering at 86 deg. F. and leaving at 96 deg. F.

Chiller pressure drop -	16.0 Ft.
Condenser pressure drop -	9.8 Ft.

Auxiliary chilled water requirement - 25 GPM

The condition of the chillers appears to be good. Some problems were experienced a few years ago with corrosion of the tube sheets in the condensers, which may have been due to electrolysis or perhaps sulfuric acid.

Anodes have been installed to combat electrolysis and repairs were made to the tube sheets.

According to the report from the operating staff, no further corrosion has taken place and the repairs have held.

A1-2-2 CHILLED WATER PUMPS

Chilled Water Pump No. 1 (Two Speed)

Canada Pumps Model # 5SL Two Speed Motor
 Capacity: 685/342 US GPM
 Head Pressure: 96/24 Hd. Ft.
 Motor Speed: 1750-875 RPM HP-25
 Serial No.: 58584-2P3 Order # 585842

Chilled Water Pump No. 2

Canada Pumps Model # 5SL
 Capacity: 685 US GPM
 Head Pressure: 96 Hd. Ft.
 Motor Speed: 1750 RPM HP-25
 Serial No.: 58584-2P4 Order # 585842

Condition

Both pumps show signs of badly leaking packing glands.

A1-2-3 CONDENSER WATER PUMPS

Condenser Water Pump No. 1

Canada Pumps Model # 5SL
Capacity: 975 US GPM
Head Pressure: 56 Hd. Ft.
Motor Speed: 1750 RPM HP-25
Serial No.: 585842-P5 Order # 585842

Condenser Water Pump No. 2

Identical to No. 1 but Serial No. 585842-P6.

Condition

Both pumps show signs of leaking packing glands and corroded pump shafts.

As an added note we would like to point out here that because of the high sulfur content of the boiler flue gases, the prevailing wind direction and the proximity of the cooling tower to the stacks, sulfuric acid probably has been formed in the condenser water system. This condition no doubt has contributed to a low PH factor, with resulting corrosion at the pump shafts and in the condensers.

A1-2-4 COOLING TOWER

The cooling tower located on the roof is manufactured by Marley Canadian Limited, and is designed to cool 1950 US GPM of water from 95 deg. F. to 85 deg. F. with air entering at 75 deg. W. B.

Problems of inadequate cooling have been experienced with the tower, when both chillers have been in operation.

**SECTION A - STUDY OF CITY HALL BOILER PLANT WITH RESPECT TO
THE FEASIBILITY OF OBTAINING HEATING AND COOLING
FROM THIS PLANT FOR THE THEATRE-AUDITORIUM**

SECTION A2 - PROVIDING HEATING FROM THE CITY HALL PLANT

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SECTION A2PROVIDING HEATING FROM THE CITY HALL PLANTA2-1 PROPOSED HEATING PLANT ARRANGEMENT

This section outlines the proposed method of obtaining heating facilities for the Theatre-Auditorium from the City Hall plant. The following sub-sections describe the recommended system components.

A2-1-1 EXISTING PLANT CAPACITY

Our investigation indicates that conversion of the existing boilers to natural gas firing will produce a maximum steam output of 18,100 lbs/hr., made up as follows:

Boiler # 1	-	6,900 lbs/hr.
" # 2	-	6,900 lbs/hr.
" # 4	-	<u>4,300 lbs/hr.</u>
Total		18,100 lbs/hr.

A2-1-2 TOTAL REQUIREMENTS

In order to adequately heat the Theatre-Auditorium from the City Hall plant, a total steam output of 21,000 lb/hr. is required.

City Hall (Actual Max. Demand)	11,000 lb/hr.
Theatre-Auditorium (Estimated Max. Demand)	<u>10,000 lb/hr.</u>
Total	21,000 lb/hr.

A plant of this size usually consists of two boilers, each capable of handling 65% - 70% of the anticipated maximum load. Therefore, each boiler output, in this case, should be approximately 15,000 lb/hr. The nearest standard packaged boiler to this capacity is rated at 500 HP with an output of approximately 17,000 lb/hr. steam. The proposed new boiler plant will consist of:

New Boiler #1	-	17,000 lb/hr.
" " #2	-	17,000 lb/hr.
Existing Boiler #4 -		<u>4,300 lb/hr.</u>
Total Output		38,300 lb/hr.

This arrangement will provide maximum flexibility of operation, with boiler # 4 also being available for light demands during summer months.

A2-1-3 THEATRE-AUDITORIUM SYSTEM

Transmitting low pressure steam to the Theatre-Auditorium was considered and studied, but abandoned due to the following problems:

- 1.) Excessively large pipe size required for steam main, to eliminate pressure drop.
- 2.) Sloping of steam main to allow condensate flow.
- 3.) Provision for dripping and trapping condensate, requiring manholes for service access.
- 4.) Corrosion conditions, particularly in the condensate return line.

The most economical arrangement would be a hot water piping loop between the City Hall and the Theatre-Auditorium. The existing boiler room does not have sufficient space to accommodate steam-to-water heat exchangers, circulating pumps, and allied controls. However, the east apparatus room in the City Hall basement has ample space to do so.

The system planned then consists of a new 10" steam line routed from the revamped steam-header in the boiler room through the tunnel, along the east side, to a bank of three heat exchangers located in the east apparatus room as shown on drawing A-3.

Heat of the steam is transferred by means of the exchangers to a hot water circulating system consisting of two circulating pumps operating in parallel, in an 8" pipe loop supplying to, and returning from the Theatre-Auditorium.

Two circulating pumps were chosen so that on light heating demand one may be shut down or in case of breakdown of a pump, the other would be able to carry about 2/3 of the maximum heating load.

Condensate would be returned from the exchangers through a 3" condensate line to the condensate receiver in the boiler room by means of condensate receiver tank with duplex pumps located in the east apparatus room.

A2-1-4 NEW BOILERS

The new boilers would be Cleaver Brooks or equal, steam type as follows:

Type: Four Pass Horizontal Fire Tube
 Model No.: CB 200-500 15 psi
 Ratings: 17, 250 lbs. steam per hour
 (@ 212 deg. F. or 500 BHP)
 Fuel: Natural Gas with No. 2 Oil as standby fuel

For complete specifications, etc., see exhibit A3.

A2-1-5 EXCHANGERS

A bank of three exchangers would be installed in the apparatus room. The exchangers would be as follows:

S. A. Armstrong Heat Exchanger WS-166-2 or equal
 16" shell dia. 6'10" overall length, 2 Pass
 Mounting saddles included
 Each capable of heating 350 US GPM of water from 180
 deg. F. to 205 deg. F. with 5 psi steam in shell.
 Max. water pressure - 125 psig
 For details see exhibit A4.

A2-1-6 HOT WATER PIPING

Two 8" insulated schedule 40 pipes would be installed on hangers in the east apparatus room and exit in the area way at the east wall.

The 8" HW pipes would be installed buried between the City Hall and the Theatre-Auditorium as approximately noted on the site plan.

Underground installation would be by Ric-Well method by which two 8" schedule 40 pipes are installed side by side in a 24" conduit consisting of galvanized spiral steel tubing protected by an epoxy coating. The pipes are insulated inside the conduit with 1-1/2" calcium silicate which is of non-deteriorating type. The conduits are pre-assembled and delivered in lengths of 20 feet. They are field welded and finished on site. See drawing A-3 for proposed routing of underground piping.

Inside the Theatre-Auditorium the piping would be run exposed in a tunnel to the mechanical room.

A2-1-7 HOT WATER CIRCULATING PUMPS

The two hot water circulating pumps installed in the east apparatus room would be as follows:

S. A. Armstrong Series 4600, or equal, horizontal split case double suction pumps, size 4" E.
Capacity: 500 US GPM each at 45 ft. T. D. head
Motors: 10 HP, 3/60/575V, 1750 RPM

For details see exhibit A5.

A2-1-8 CONDENSATE RETURN SET

A condensate receiver and duplex pump set, installed in east apparatus room adjacent to exchangers, would return condensate to new receiver tank in boiler room. The condensate return set would be as follows:

S. A. Armstrong Series 1650, or equal, size 5030 duplex condensate receiver and pump set, complete with 24" dia. x 36" long receiver tank (72 US Gals.) Pumps suitable for 50,000 sq. ft. EDR, 75 US GPM of condensate at 30 psi discharge pressure. Motors 3 HP, 1750 RPM, 3/60/575V. Includes float operated switch, interconnecting piping and common baseplate for pumps and tank. For details see exhibit A4.

A2-2 SCOPE OF WORK AND COST ESTIMATE

A2-2-1 CHANGES IN BOILER ROOM

The following changes need to be made in the boiler room:

1.) Install New Boilers

The new boilers would be installed in the location shown in order to be able to re-tube them. See drawing A-2.

To move the new boilers into the boiler room, it would be necessary to enlarge the opening in the east wall.

New breeching would be required from the new boilers to the existing stacks.

2.) Remove Existing Boilers

The existing boilers would probably be removed for scrap value only and hence, could be dismantled inside the room, and cut up for ease of handling.

3.) Changes to Steam Piping

The steam take-offs from the boilers would have to be re-vamped to suit the load and connected to existing 12" steam header.

4.) Gas Piping

The 4" gas main would be extended inside the building to the boilers, together with a reducing station, valves, etc.

5.) Boiler Control Panel

The existing control panel must be removed to provide clearance for the new boilers.

The parameters metered, recorded, etc., are not as significant with the new fuels as they were with the heavy oil.

Steam production, etc., is immaterial. Perhaps only the quantity of steam supplied to the Theatre-Auditorium system would be of value for accounting purposes, but this could be achieved with a simple steam meter.

The new boilers would have built-in automatic control for firing and fuel-air ratios.

6.) Fuel Oil System

The existing fuel oil system can remain and would be re-used for the No. 2 fuel oil standby fuel.

New piping connections would be made from the system to the boilers.

All electric heaters could be removed or made inoperative.

7.) Flue Gas Stacks

Changes are necessary to the existing stacks, in accordance with the requirements of the Department of Energy and Resources Management, Air Management Branch. Refer to comments in Section A1, item 1-7, Flue Gas Stacks.

8.) Soot Blowing System

The soot blowing system would not be required for the new

boilers, and must be removed to provide space for the new condensate tank.

The compressor may provide a useful function for other purposes and should be retained by the owner.

9.) Condensate System

A second condensate tank of 460 Imp. gallon capacity would be installed to receive the condensate from the Theatre-Auditorium system.

A new boiler feed pump would be furnished for each boiler with one standby pump and cross connection arrangement, so that the standby pump could feed either boiler.

A cross connection would be installed between the new and existing condensate tank.

One of the existing condensate pumps would be retained to feed existing boiler #4.

The new boiler feed pumps would be Smart-Turner Model 1-1/2 GDUE or equal, horizontal end suction pumps, each to handle 70 US GPM at 60 Ft. Hd. when operating at 1750 RPM. See exhibit A6.

10.) Electrics

An allowance is carried for electric changes and alterations required.

11.) Controls

An allowance is carried for revisions to control system as may be required.

12.) Miscellaneous, Etc.

An allowance is carried for miscellaneous insulation, steel work, etc.

A2-2-2 CHANGES AND NEW INSTALLATION EXTERIOR TO BOILER ROOM

1.) Install 10" Steam Line

A 10" steam line insulated with 1-1/2" thick fibreglas insulation would be installed along the east tunnel wall between boiler room

steam header and exchangers. Steel channel ladder supports provided similar to those along the west wall.

The line would be anchored at each turning point in tunnel, similar to existing lines, and provided with the necessary expansion provisions.

2.) Install 3" Pumped Condensate Line

A 3" condensate line insulated with 1" fibreglas insulation would be installed along the east side of the tunnel below the new steam line, complete with expansion provision and anchors.

3.) Exchangers

A bank of three steam to water exchangers would be installed in the east apparatus room, mounted on elevated steel supports.

The heat exchanger shells would be insulated with 1-1/2" fibreglas insulation and hard finish cement. Steam, condensate connections to be made with all necessary control valves, traps, strainers, etc.

4.) Circulating Pumps

The hot water circulating pumps would be installed adjacent to exchangers on suitable concrete bases, dowelled to existing concrete floor slab. All piping connections to be made to the heat exchangers and the hot water piping system.

5.) Condensate Return Set

Condensate connections to be made from the heat exchangers to the tank on the condensate return set and thence connected to the pumped condensate return line.

6.) Piping to Theatre-Auditorium

Install two 8" hot water heating lines in east apparatus room, one to Theatre-Auditorium and one return.

Install two 8" lines buried between City Hall and Theatre-Auditorium wall.

Install and terminate 2 - 8" lines inside the Theatre-Auditorium mechanical room.

7.) Electrics

An allowance is carried for electrics.

8.) Controls

An allowance is carried for temperature controls.

9.) Miscellaneous

An allowance is carried for miscellaneous, insulation, steel work, making good, etc.

A2-2-3 COST ESTIMATES

1.) On the basis of the foregoing scope of work, cost estimates have been prepared and are submitted herewith.

2.) Changes in boiler room, as described under item A2-2-1, at an estimated cost of:

One Hundred Thirty-Four Thousand Dollars (\$134,000.00)

3.) Changes and new installation exterior to the boiler room, as described under item A2-2-2, at an estimated cost of:

Two Hundred and Nine Thousand Dollars (\$209,000.00)

4.) Total Estimate - Three Hundred Forty-Three Thousand Dollars (\$343,000.00) - Federal Sales Tax included, Provincial Sales Tax extra.

A2-2-4 FUEL CONSUMPTION COSTS

1.) The present City Hall annual requirements total approximately 40,000 M. C. F. natural gas equivalent. The Theatre-Auditorium annual requirements are estimated at 30,000 M. C. F. natural gas equivalent, which results in a total of 70,000 M. C. F. annual gas consumption, for combined plant operation.

2.) Combined Plant Operation

This operation would be eligible for an interruptable gas contract, available when annual consumption exceeds 45,000 M. C. F., and at an approximate cost of \$.60 per M. C. F.

Estimated Annual Fuel Cost - \$42,000.00
 (Based on 70,000 M. C. F.)

3.) Separate Plant Operation

Neither plant is large enough to qualify for an interruptable gas contract, and it would be necessary to purchase gas on a firm rate schedule averaging \$.85 per M. C. F. Estimated annual fuel costs are as follows:

City Hall - 40,000 M. C. F.	\$34,000.00
Theatre-Auditorium - 30,000 M. C. F.	<u>25,500.00</u>
Total	<u>\$59,500.00</u>

- 4.) The above figures indicate a combined plant operation will allow annual fuel savings of \$17,500.00.

A2-2-5 SUMMARY

Briefly, the estimated costs of a heating plant to serve both City Hall and Theatre-Auditorium are:

1.) Work in Boiler Room -	\$134,000.00
2.) Work exterior to Boiler Room, including connections to Theatre- Auditorium -	<u>209,000.00</u>
Total Estimated Cost -	<u>\$343,000.00</u>

In comparison, separate new plant for each building would cost approximately as follows:

1.) City Hall - Based on replacing existing boilers with two new packaged dual fired Gas-Oil boilers, as per Section B6-2 -	\$ 68,000.00
2.) Theatre-Auditorium - Based on providing in-building complete boiler plant, consisting of two packaged dual fired Gas-Oil boilers and all ancillaries -	\$106,000.00

Summarizing, the new combined plant versus new separate plants compare as follows:

Estimated total combined plant cost -	\$343,000.00
Estimated City Hall plant cost - (based on new boilers)	68,000.00
Theatre-Auditorium portion -	<u>\$275,000.00</u>
Estimated cost - separate Theatre-Auditorium boiler plant -	<u>106,000.00</u>
Premium cost for combined plant and Theatre-Auditorium connections -	<u>\$169,000.00</u>

However, savings in fuel and operating staff can be applied to this premium capital cost.

Fuel Savings - \$17,500.00 annually
(See item A2-2-4, Fuel Consumption Costs)

Operating Staff Savings -

Combined plant requires no additional stationary engineers. The Theatre-Auditorium will require equipment maintenance staff, but it is possible that major equipment could be serviced by the present City Hall staff, thus keeping Theatre-Auditorium personnel to a minimum in number and in necessary qualifications.

Separate plants however, would require double the present number of stationary engineers.

Therefore, staff and operating expenses (other than fuel) are compared as follows:

Separate Plant Basis

Stationary engineers' wages - \$136,000.00

Combined Plant Basis

Stationary engineers' wages - \$68,000.00
T. A. equipment maintenance,
wages - 10,000.00

Total - 78,000.00

Saving - \$ 58,000.00

Total operating savings with combined plant are as follows:

Staff -	\$58,000.00
Fuel -	<u>17,500.00</u>
Gross Annual Saving -	<u>\$75,500.00</u>

Based on a ten (10) year retirement of the \$169,000.00 premium capital expenditure for combined plant facilities, with interest at 9-3/4%, the annual cost would be \$27,000.00. This would result in a net annual saving of \$48,500.00.

However, such a view point can only be considered on a long range basis. If central plant heating were to be available within the next 2 to 3 years, the obvious choice would be to connect to such a system. Preliminary figures for purchased steam show approximate average cost of \$2.50 per 1000 lbs., which could not be bettered by purchasing and operating own plant.

SECTION A - STUDY OF CITY HALL BOILER PLANT WITH RESPECT TO
THE FEASIBILITY OF OBTAINING HEATING AND COOLING
FROM THIS PLANT FOR THE THEATRE-AUDITORIUM

SECTION A3 - PROVIDING COOLING FOR THE THEATRE-AUDITORIUM

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SECTION A3

PROVIDING COOLING FOR THE THEATRE-AUDITORIUM

The maximum cooling requirements for the Theatre-Auditorium are approximately 540 MBH or about 450 ton/hour.

We investigated the possibility of obtaining sufficient cooling capacity from the City Hall plant by installing additional capacity in the form of one 150 ton refrigeration machine, complete with a chilled water pump, condenser water pump in the machine room, and a new cooling tower adjacent to the existing tower on the upper parking level.

One new additional 150 ton machine together with the available existing spare capacity of 300 ton, would give the 450 ton required, assuming some diversity.

We studied all aspects in detail, obtained quotations, etc., but we had to abandon the idea for technical reasons, which make the costs prohibitive.

The existing refrigeration machines are arranged to operate in parallel with the one machine in a sense serving as a standby unit. Problems have been encountered in keeping the second machine on the line when demand has exceeded the capacity of one unit.

One way of adding a machine is to parallel it up with the existing machines which space-wise is possible, but we found that the outlet temperature of the chilled water could not be controlled adequately, i. e. we could not guarantee to obtain the required temperature of 42 deg. F. during low demand periods; such water temperature is necessary to provide satisfactory dehumidification in the air handling systems.

Another way by which we could obtain the 42 deg. F. temperature would be by re-arranging the existing machines and a third new 300 ton machine in series together with a loop piping system with new circulating pumps, etc.

However, the present refrigeration room does not have the space nor the headroom required for such an arrangement, and the costs of the changes and equipment involved would be approximately four times the cost of installing a new 450 ton machine in the Theatre-Auditorium considering also that the chilled water piping required between the City Hall and the Theatre-Auditorium alone would cost close to \$100,000.00.

As far as maintenance and operating is concerned, a stationary engineer is not required for the operation of the refrigeration machine and maintenance could be taken care of by the City Hall plant personnel with some staff expansion.

We must acknowledge that there may be some advantage in not having to cope with a cooling tower at the Theatre-Auditorium, but the costs involved to avoid this are not warranted.

SECTION B - STUDY OF CITY HALL BOILER PLANT WITH RESPECT TO
THE NECESSARY ACTIONS REQUIRED TO DEAL WITH THE
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SECTION B

STUDY OF CITY HALL BOILER PLANT WITH RESPECT TO THE NECESSARY ACTIONS REQUIRED TO DEAL WITH THE PRESENT AIR POLLUTION PROBLEM

B1

GENERAL

The Corporation of the City of Hamilton was advised by the Provincial Department of Energy and Resources Management, Air Management Branch, to review the operation of the boiler plant and make the necessary changes in order to bring its operation into compliance with the current regulation.

The City is to advise the Air Management Branch not later than April 1, 1970. See exhibit B1.

We have previously under Section A, described the existing plant and some comments were made with respect to air pollution.

B2

MODIFICATIONS TO EXISTING STACKS

In order to comply with the requirements of Department of Energy and Resources Management, Air Management Branch, it will be necessary to increase the height of the existing stacks, which are presently 10 feet above ground level. The total height required will depend on the type of fuel used.

Preliminary figures obtained from the Air Management Branch are as follows:

Plant Capacity	Fuel	Stack Height Above Grade
Existing Capacity		
" "	Nat. Gas/#2 Oil Standby	16 Ft.
" "	No. 2 Oil	36 Ft.
" "	No. 6 Oil	75 Ft.
New Combined Capacity		
" " "	Nat. Gas/#2 Oil Standby	22 Ft.
" " "	No. 2 Oil	48 Ft.
" " "	No. 6 Oil	115 Ft.

Stack heights indicated for No. 6 oil are conditional on impingement against taller adjacent buildings, particularly the City Hall and the new office tower at the corner of McNab and Main Streets. We believe the height required will be much greater than shown.

On the basis of this information, we recommend the use of natural gas fuel with No. 2 fuel oil emergency standby.

All cost estimates are based on dual firing gas-oil, and include allowances to modify the existing stacks to the height required for this fuel.

B3 CONVERSION OF BOILERS NO. 1 and NO. 2

It is possible to install new burners on the existing boilers suitable for firing natural gas with No. 2 fuel oil as standby fuel.

There are a number of firms in the business of providing design and contract services to do this conversion work. We approached the Gas Machinery Co. (Canada) Limited of Toronto, and formerly of Hamilton, who had previously submitted a quotation for conversion work, but they backed out of giving us a firm updated quotation because they lost all their design information during their move from Hamilton to Toronto.

The original quotation however, was made in 1966 and was for approximately \$5,000.00 per boiler. However, this figure was apparently for the supply of the burners only and did not include installation costs.

We also approached a local firm by the name of Fuel Applications Limited, who provided us with a firm estimate for the cost of conversion. See exhibit B2.

As an alternative, United Gas Limited have submitted a proposal for conversion of burners on a rental basis for boilers No. 1 and No. 2 only. See exhibit B3.

B4 NEW BOILERS

Bearing in mind the condition of boilers 1 and 2, as previously described in Section A1, we pursued the economics of replacing the existing boilers by two new package type fire tube boilers.

The new boilers would be Cleaver Brooks or equal as follows:

Type:	Steam boilers
Model No.:	CB200-200C, 15 psi
Ratings:	200 BHP, capable of producing 6900 lbs/hr.
Fuel:	Natural Gas
Standby Fuel:	No. 2 fuel oil

For complete specifications, see exhibit B4.

The boilers will have almost the same output capacity as the existing ones.

B5 NATURAL GAS

The availability of natural gas, gas contracts, etc. has been discussed adequately in Section A1. Gas piping changes inside the building of course, need to be made. An allowance is carried for this work.

B6 PROPOSALS AND COST ESTIMATES

We propose and submit two schemes for consideration and will point out the operating cost aspects in a later chapter.

B6-1 SCHEME 1 - CONVERSION BURNERS

This would consist of replacing existing burners, with new conversion dual fired burners, gas and No. 2 fuel oil.

The following items of work are required:

1.) Conversion Burners

Replace existing burners of boilers 1 and 2 with conversion burners, complete with the necessary control changes to provide self contained operating systems for each boiler.

2.) Gas Piping

Extend 3" gas piping together with a reducing station, valves, etc. connect all three boilers, make provision for fourth boiler, and update controls on #4 boiler.

3.) Fuel Oil System

The existing fuel oil system can remain and will be re-used for the No. 2 fuel oil standby fuel, to be used in case of emergency.

New piping connections are to be made from the system to the burners.

All electric heaters can be removed or made inoperative.

4.) Electrics

An allowance for electrical work is carried.

5.) Miscellaneous

An allowance for miscellaneous work, insulation, instrument piping, alterations to flue stacks, etc., is carried.

6.) Cleaning Existing Oil System

The price quoted does not include cleaning of existing oil tanks, oil piping and transfer pumps.

We believe that this work could easily be carried out by the City Hall plant staff with assistance of the oil supplier, and hence, have carried no allowance.

Cost

The estimated construction cost for this scheme is \$26,000.00 but we have to consider that no improvements have been made to the boilers and that complete retubing will be required in the near future at an estimated cost of \$32,000.00.

SCHEME 1 ALTERNATIVE - RENTAL CONVERSION BURNERS

United Gas Limited have submitted a proposal for installation of dual fired gas-oil conversion burners at a total installed price of \$18,382.50, or a monthly rental charge of \$275.75. Refer to letter dated March 4, 1970, exhibit B3.

This proposal does not include up-dating of existing gas controls on boiler #4 or alterations to flue stacks. An allowance of \$8,000.00 should be carried for this work.

It is understood a rental contract must be negotiated for a minimum period of 24 months, and thereafter continued from month to month subject to termination by either party on thirty (30) days notice in writing.

B6-2 **SCHEME 2 - NEW BOILERS**

This scheme would consist of installing two new fire tube boilers as previously described of almost similar capacity of the existing ones, designed and equipped for firing gas and No. 2 fuel oil.

The following items of work are required:

1.) New Boilers

Install new boilers, provide new foundations and new breeching.

2.) Existing Boilers

Remove both existing boilers no. 1 and 2.

3.) Steam Piping

Change steam piping and connect new boilers.

4.) Condensate Piping

Change condensate piping and reconnect new boilers, retaining receiver tank and pumps.

5.) Gas Piping

Extend 4" gas piping together with a reducing station, valves, etc., connect all three boilers and make provision for fourth boiler.

6.) Fuel Oil System

The existing fuel oil system can remain and will be re-used for the No. 2 fuel oil standby fuel, to be used in case of emergency.

New piping connections are to be made from the system to the burners.

All electric heaters can be removed or made inoperative.

7.) Boiler Control Panel

The existing control panel must be removed to provide space for new boiler tube removal.

The parameters metered, recorded, etc., are not as significant with the new fuels as they were with the heavy oil.

The new boilers would have built-in automatic control for firing and fuel-air ratios.

8.) Soot Blowing System

This system is of course not required and will not be reconnected.

9.) Flue Gas Stacks

Alterations required, allowance carried.

10.) Electrics

Allowance carried.

11.) Miscellaneous Work, Insulation, Etc.

An allowance is carried for miscellaneous work, insulation, steel work, making good, etc.

Cost

The estimated construction cost of the scheme is \$68,000.00 but we should consider that we now have two new boilers, that will operate about 10% more efficiently than the water-tube boilers if converted. The new boilers should operate at least 4 - 5 years without requiring retubing.

Retubing is much less complicated and if a tube did show leakage, it could be plugged quite easily.

B7

EXISTING PLANT CONVERSION TO NO. 2 FUEL OIL

As an economic study, we investigated the possibility of using No. 2 fuel oil with the existing burners. Adaptation of the burners presented no problem, and could be done at a nominal cost - approximately \$2,000.00.

Cleaning the existing fuel oil tanks, piping and pumps, and at the same time maintaining boiler operation would be difficult. This could be accomplished by jury rigging a temporary fuel tank outside the boiler room, by passing the existing piping system, and timing the work during summer months when consumption is low.

However, the required alterations to the existing stacks proved very costly. It would be impossible to add 26 feet to the existing stacks, and entirely new stacks would have to be installed. With the use of No. 2 fuel oil, these would have to be Underwriters Laboratories listed refractory lined type, suitable for free standing installation since no

space is available for guy wires. The weight of such stacks, approximately 18,000 lbs. each, would necessitate new foundations in the boiler room. The total installed cost of three stacks is estimated at \$45,000.00 minimum.

The cost of No. 2 fuel oil at 14 - 15 cents per Imp. gallon compares with natural gas on a firm rate schedule of 85 cents per M. C. F.

Since no advantage is available in the cost of fuel, the estimated total expenditure of \$50,000.00 for conversion to No. 2 fuel oil is completely uneconomical.

B8

FUEL CONSUMPTION COSTS

The present plant consumes approximately 230,000 Imp. gallons of #6 fuel oil annually, which at \$.08 per gallon amounts to approximately \$18,400.00 per year, which would include electric heating required to lower viscosity, pumping costs and any additives that may be required.

Converting the total heat input of fuel oil to natural gas we calculate that approximately 40,000,000 C. Ft. annually will be required with converted boilers. At the firm contract rate, the annual fuel cost of gas would be approximately \$34,000.00 per annum.

If new fire-tube boilers with a higher operating efficiency were installed, the annual fuel cost of gas would be approximately \$31,000.00, a difference of \$3,000.00 per annum.

B9

SUMMARY

Briefly the comparative costs of the various alternatives are as follows:

1.) Conversion of Existing Burners

- | | | |
|----|--|---------------------|
| a) | Owner purchase of conversion gas-oil burners and alterations to flue stacks | \$26,000.00 |
| b) | Rental of conversion gas-oil burners from United Gas Limited - minimum 24 month contract | \$ 275.75 per month |
| | Purchase of conversion burners from United Gas Limited | \$18,382.50 |

JOB DESCRIPTION City Hall

Section A2 (Heating for the Theatre-Auditorium)

Sub. A2-2-1, Changes to Boiler Room

AREA ACC'T	SUB ACC'T	ITEMS OF WORK	QUANT. AND UNIT	UNIT COST	TOTAL MAN'L LAB'R COST	TOTAL MATERIAL COST	TOTAL ITEM COST	JOB NO. CHARGE AREA
A2-1-8	1	Install New Boilers						
"	1A	Boilers	2				\$ 37,600.	
"	1B	To Move In and Set					6,000.	
"	1C	Foundations					8,000.	
"	1D	Breeching					3,000.	
"	1E	Cost of Enlarging Opening					4,000.	
"	1F	Alterations to Stacks					6,000.	
"	2	Remove Existing Boilers						
"	2A	Dismantle)						
"	2B	Remove)					4,000.	
"	3	Changes to Steam Piping					8,500.	
"	4	Gas Piping						
"	4A	Extend Gas Piping					2,000.	
"	4B	Connect Boiler #4					500.	
"	5	Boiler Control Panel						
"		Remove Boiler Control						
"		Panel & Associated Piping					2,500.	
SUB TOTALS								
CONTINGENCIES & OTHER DIRECT JOB COST								
ENGINEERING AND SUPERVISION								
TOTAL JOB COST								
\$ 82,100.								

JOB DESCRIPTION			City Hall			Section A2 (Heating for the Theatre-Auditorium)			JOB NO.		
			Sub. A2-2-1. Changes to Boiler Room						7004		
AREA ACC'T	SUB ACC'T	ITEMS OF WORK	QUANT. AND UNIT	UNIT COST	TOTAL MAN'L LAB'R COST	MAT'L COST	L'BOUR COST	TOTAL ITEM COST	CHARGE AREA		
A2-1-8	6	Fuel Oil System						\$ 82,100.			
"	6A	Change Piping & Reconnect Boilers						2,000.			
"	7	Soot Blowing System									
"		Remove & Turn Over to Owner						1,000.			
"	8	Condensate System									
"	8A	Piping						3,600.			
"	8B	New Pumps (Boiler Feed)	3					1,395.			
"	8C	New Receiver Tank						800.			
"	8D	Setting Pumps & Tank						1,000.			
"	9	Electrics									
"		Boiler Room						3,000.			
"	10	Miscellaneous Insulation						6,500.			
SUB TOTALS											
CONTINGENCIES & OTHER DIRECT JOB COST											
ENGINEERING AND SUPERVISION											
TOTAL JOB COST											
\$101,395.											
20,280.											
12,170.											
\$133,845.											

DESIGN ENGINEER
DATE
CHECKED

JOB NO. 7004
CHARGE
AREA

JOB DESCRIPTION			Section A2 (Heating for Theatre-Auditorium)			JOB NO.		
			Sub. A2-2-2, Work Exterior to Boiler Room			7004		
AREA ACC'T	SUB ACC'T	ITEMS OF WORK	QUANT. AND UNIT	UNIT COST MAN'L LAB'R COST	TOTAL MAT'L LABOUR COST	TOTAL ITEM COST	TOTAL LABOUR COST	CHARGE AREA
A2-1-9	6	Piping to Theatre-Auditorium						
"	6A	8" Inside Piping						
"	6B	2-8" Ricwell Buried 450' Installed						
"	6C	Breaking & Repair to Pavement						
"	7	Electrics						
"	8	Miscellaneous						
"	8A	Insulation						
"	8B	Cutting & Patching						
"	8C	Work on Areaway						
SUB TOTALS								
CONTINGENCIES & OTHER DIRECT JOB COST								
ENGINEERING AND SUPERVISION								
TOTAL JOB COST								
20%								
\$158,060.								
31,600.								
18,970.								
\$208,630.								

DESIGN ENGINEER
DATE
CHECKED

JOB NO. 7004
CHARGE
AREA

E-5

JOB DESCRIPTION		City Hall		Section B (Pollution) Sub. B5-2	
		Scheme 2 - New Boilers			
AREA ACC'T	SUB ACC'T	ITEMS OF WORK	QUANT. AND UNIT	UNIT COST MAN'L LAB'R	TOTAL MAT'L COST
B5-2	1	Install New Boilers	2		\$20,722.
"	1A	Boilers			4,000.
"	1B	Move In and Set			1,000.
"	1C	Foundations			1,000.
"	1D	Breeching			1,000.
"	1E	Alterations to Stacks			6,000.
"	2	Remove Existing Boilers			
"	2A	Dismantle)			
"	2B	Remove)			4,000.
"	3	Steam Piping			900.
"	4	Condensate Piping			400.
"	5	Gas Piping			
"	5A	Extend 3" Piping			2,000.
"	5B	Connect Boilers Inc. Exg. # 4			500.
"	6	Fuel Oil System			
"	6A	Change Piping & Reconnect Boilers			300.
SUB TOTALS					\$40,822.
CONTINGENCIES & OTHER DIRECT JOB COST					
ENGINEERING AND SUPERVISION					
TOTAL JOB COST					

JOB DESCRIPTION				City Hall			
Section B (Pollution) Sub. B5-2							
Scheme 2 - New Boilers							
AREA ACC'T	SUB ACC'T	ITEMS OF WORK	QUANT. AND UNIT	UNIT COST	TOTAL MAT'L COST	TOTAL LABOUR COST	TOTAL ITEM COST
B5-2	7	Boiler Control Panel					\$40,822.
"		Remove Panel & Associated Piping					2,500.
"	8	Soot Blowing System					
"		Disconnect System from Boilers					500.
"	9	Electrical					
"	9A	Allowance					500.
"	10	Miscellaneous					
"	10A	Insulation					3,000.
"	10B	Making Good					2,000.
"	10C	Boiler Access					2,000.
SUB TOTALS				\$51,322.			
CONTINGENCIES & OTHER DIRECT JOB COST				20%			
ENGINEERING AND SUPERVISION				10,264.			
TOTAL JOB COST				6,158.			
				\$67,744.			

EXHIBITS

- A1 QUOTATION, CANADIAN VICKERS LIMITED
- A2 APPLICATION FOR RULING RE: LARGER PLANT,
DEPARTMENT OF ENERGY AND RESOURCES
- A3 REQUEST FOR QUOTATION AND QUOTATION FOR
17,000 LBS/HR BOILERS
- A4 REQUEST FOR QUOTATION AND QUOTATION FOR
EXCHANGERS AND CONDENSATE PUMPS
- A5 REQUEST FOR QUOTATION AND QUOTATION FOR
HOT WATER CIRCULATING PUMPS
- A6 REQUEST FOR QUOTATION AND QUOTATION FOR
BOILER FEED PUMPS
- B1 LETTER - DEPARTMENT OF ENERGY AND RESOURCES
MANAGEMENT
- B2 QUOTATION FROM FUEL APPLICATIONS LIMITED
- B3 RENTAL PROPOSAL - UNITED GAS LIMITED
- B4 REQUEST FOR QUOTATION AND QUOTATION FOR
6900 LBS/HR BOILERS

EXHIBIT A1

*Harry
Forward a copy of
for my
thank you*

CANADIAN VICKERS LIMITED

5000 NOTRE DAME EAST, MONTREAL 404, CANADA

TELEPHONE (514) 256-2651
NIGHTS AND HOLIDAYS
INFORMATION 256-2761
SHIP REPAIRS 256-2290

CABLES: "VICKERS MONTREAL"

REF. NO. 2-3381 DN/OB

QUOTATION

Corporation of the City of Hamilton,
City Hall,
Hamilton, Ontario.

May 9, 1969.

Attention: Mr. H. Convey.

Subject: Retubing of 40 CPM/3 V-K Boiler
in Hamilton City Hall.

Gentlemen,

We acknowledge receipt of your inquiry of May 7.
Subject to the conditions herein and on reverse side of this
sheet we have pleasure in quoting as follows:

This confirms today's telephone conversation between
our Mr. J. MacLean and your Mr. H. Convey.

For supplying, bending to shape as necessary, and
installing one (1) complete set (430) of 2" O.D. x 13 BWG
Boiler Tubes to A.S.T.M. A-178-A, in one (1) 40 CPM/3 V-K
Boiler in Hamilton City Hall. Also, for dismantling boiler
walls as required, removing existing tubes, and replacing
Key caps, bolts, soot blower bearings, tiles, insulation etc.,
using new material where needed, and renewing bricksetting
where required,

BUDGET PRICE: \$16,000.00
(Sixteen thousand dollars).

Our price is exclusive of all taxes, federal,
provincial or municipal.

Should you decide to proceed with the subject re-tubing,
we would carry out the work of installation strictly on a cost-plus

/2

-2-

Corporation of the City of Hamilton

2-3381 LM/PB

basis, and our above price does not include for any repair or renewal of gas baffles, soot blower element, framing or casings. If, in the execution of the work, such repairs or renewals were found to be necessary, this would be extra to our quoted price.

Yours very truly,

CANADIAN VICKERS LIMITED,
INDUSTRIAL DIVISION,

J. Berger
Boiler Sales.

Al

EXHIBIT A2



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

February 17, 1970

Department of Energy and Resources Management,
Air Management Branch,
554 Main Street East,
Hamilton 22, Ontario.

Attention: Mr. J. Chrystman, P. Eng.,
District Engineer.

Re: Hamilton City Hall Boiler Plant,
Our Project Number 7004.

Dear Sir:

Relative to our recent telephone discussions regarding the subject boiler plant, we hereby confirm the proposed changes we plan to submit to the City Hall, in order to overcome the present air pollution problem.

We would appreciate receiving a firm ruling from your office, using the existing stacks, on the basis of the plant operating under the following conditions:

1.) Plant Remaining at Existing Capacity

Existing boilers to be converted to natural gas, with No. 2 fuel oil as emergency stand-by. Alternatively, new boilers of same capacity as existing may be provided, to operate with same fuel.

Total Input - 14,000 MBH

Gas to be supplied on a firm contract basis.

Continued...

A2

2.) Plant Increased in Capacity

Existing boilers to be replaced with new boilers of larger size, fired with natural gas, with No. 2 fuel oil as emergency stand-by.

Total Input - 41,000 MBH

Gas to be provided under an interruptable contract. The United Gas Company have advised us that gas shut-off under this type of contract will occur only at times of extreme emergency, and not for any fixed time period.

If further information is required, please contact our office. We look forward to receiving an early reply.

Yours truly,



C. Palmers, Eng. Tech.,

CP:at

Comments regarding the stack heights to comply with air management requirements based on verbal information received from the Air Management Branch.

Confirming letter to follow.

EXHIBIT A3



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

REQUEST FOR QUOTATION

RFQ #7004-1A

PROJECT #7004
City Hall, Hamilton

February 12, 1970

TO: York Shipley of Canada

The Waterloo Manufacturing Co. Ltd.

ATTENTION:

Please submit in triplicate your quotation for the equipment or services as listed below. Quotations will be used for engineering estimates. Receipt of quotation would be appreciated before 12:00 Noon, February 16th, 1970.

Include descriptive literature and overall dimensions of equipment that you propose to supply.

Quote price including federal sales tax but excluding provincial tax.

Equipment

Two (2) in quantity package boilers, 500 BHP, each capable of producing 17,000 Lbs/Hr. saturated steam at 12 psig.

Fuel: Natural Gas @ 5psi inlet pressure

Standby Fuel: #2 Fuel Oil

Include delivery charges to job site, 90 day service and initial start-up.

Project Co-ordinator,
C. Palmers:

This replaces our request of February 10, 1970 for price on two 300 HP boilers.

A3

PROPOSAL

Cleaver Brooks of Canada, Limited

STRATFORD, ONTARIO

Page ____ of ____ Pages

To Quist & Associates Ltd. Proposal No. ~~XXXX~~ ... 703-10
 918 Main St. E.
 Address ... Hamilton 22, Ontario, Att: Mr. C. Palmer Date Feb. 13/70
 SUBJECT: ... Hamilton City Hall Your Reference No. From

TWO (2) Cleaver-Brooks boiler burner units as follows:

Type: four pass horizontal firetube

Model No.: CB200-500, 15 PSI

Ratings: 17,250# stm per hr f/a 212°F. or 500 BHP

Fuel: natural gas & #2 oil

In accordance with attached specifications: C9-3116, 3314, 3118

Extras included beyond our standard specifications:

1. gas pressure regulator.
2. gas relief valve.
3. control circuit transformer mounted.
4. one year warranty, startup & 90 days free service from date of startup.

Not included: installation.

NET PRICE: \$37,600.00

Federal tax included 11%

Provincial tax extra

NOTE: Heating contractors commission is included in price.

Shipping	FOB Factory, freight allowed on truck to	Current	Characteristics	550/3/60	Approximate Shipping Weight
Terms	curb jobsite				
Payment				Approximate Shipment after Receipt	
Terms	Net 30 days from date of shipment	of Order and Complete Details			8 - 10 weeks after approved drwgs received.

THE TERMS AND CONDITIONS OF SALE PRINTED ON THE REVERSE SIDE OF THIS SHEET, UNLESS EXPRESSLY EXCEPTED HEREIN, ARE PART OF THIS PROPOSAL.

THIS PROPOSAL IS SUBJECT TO CHANGE OR WITHDRAWAL WITHOUT NOTICE. PRICES QUOTED SHALL BE FIRM FOR THIRTY (30) DAYS FROM DATE OF PROPOSAL UNLESS OTHERWISE SPECIFIED. ANY EXTENSION OF TIME IS SUBJECT TO APPROVAL OF COMPANY. IF ACCEPTED BY THE PURCHASER IT SHALL BECOME A CONTRACT WHEN APPROVED BY AN AUTHORIZED COMPANY REPRESENTATIVE AND MAY THEN BE MODIFIED BY WRITTEN AGREEMENT ONLY. NO STATEMENTS OR UNDERSTANDINGS RELATING TO THE SUBJECT MATTER, OTHER THAN THOSE SET FORTH HEREIN, SHALL BE BINDING ON CLEAVER-BROOKS OF CANADA, LIMITED (HEREINAFTER REFERRED TO AS THE "COMPANY").

PROPOSAL FURNISHED BY:

Waterloo Mfg. Co., Ltd.

Per:

F. A. Gerth/bh

Date ACCEPTED _____ 19_____

By _____ PURCHASER

EXHIBIT A4



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

REQUEST FOR QUOTATION

RFQ #7004-9

PROJECT #7004
City Hall, Hamilton

February 17, 1970

TO: S. A. Armstrong Limited,
1400 O'Connor Drive,
Toronto 16, Ontario.

ATTENTION: Richard J. Fahey

Please submit in triplicate your quotation for the equipment or services as listed below. Quotations will be used for engineering estimates. Receipt of quotation would be appreciated before 12:00 Noon, February 19, 1970.

Include descriptive literature and overall dimensions of equipment that you propose to supply.

Quote price including federal sales tax but excluding provincial tax.

Equipment

1. Three (3) only Armstrong WS 166-2 convertors, to heat 350 US GPM (each) of water from 180 deg. F. to 205 deg. F., when using steam in the shell at 5 psi. Convertors shall be complete with type B cast iron flanged heads.

2. Armstrong series 1650, size 5030 duplex condensate receiver and pump set, complete with 24" diam. x 36" long receiver tank (72 USG) Pumps suitable for 50,000 sq. ft. EDR, 75 US GPM of condensate at 30 psi. discharge pressure. Motors: 3 HP, 1750 RPM, 60/3/575. Include float operated switch, interconnecting piping and common baseplate for pumps and tank.

C. Palmers,
Project
Co-ordinator:

QUOTATION

S. A. ARMSTRONG LIMITED

TELEPHONE 755-2291

1400 O'CONNOR DRIVE,
TORONTO 16, CANADAPLEASE REFER TO
THIS QUOTATION NUMBER
WHEN ORDERINGQUOTATION NO. *Burlington*

PAGE 1.

DATE *Feb. 19, 1970*TO: Quist & Associates Ltd.,
918 Main St., East,
Hamilton, Ontario.

ATTENTION: Mr. D. Dickie

GENTLEMEN:

SUBJECT: *RFQ-7004-9*
City of Hamilton

In keeping with your request, we are pleased to quote you on the undermentioned items, subject to Terms and Conditions stated on the face and reverse side of the signature page of this quotation.

FEDERAL SALES TAX - *125 included*PROVINCIAL SALES TAX - *Extra*

TERMS -

ON APPROVED CREDIT RATING

F.O.B. *Toronto, with freight allowance included to Hamilton*SHIPMENT: Subject to contingencies, we would expect to make shipment
your Order and settlement of all details.*as arranged*

after receipt of

PRICES ARE SUBJECT TO ADJUSTMENT to comply with the Company's price in effect at date of shipment.
REFER TO TERMS AND CONDITIONS ON REVERSE SIDE.

We appreciate the opportunity you have given us to quote on your requirements and we hope that our quotation will merit your approval. You may be assured that your Order will receive our best attention.

Should the information we have given you be insufficient, further details will be furnished on your request.

S. A. ARMSTRONG LIMITED

Per:- *Richard J. Fahy,*
Richard J. Fahy,
Hamilton - Niagara Repres.

Pumps • Hydronic Specialties • Heat Exchangers • Water Systems • Refrigeration Vessels

ITEM	QUANTITY	DESCRIPTION	PRICE
1.	3 only	Armstrong WS 166-2 converters, to heat 350 USGPM (ea.) of water from 180°F to 205°F, when using steam in the shell at 5 psi. E.D. tubes - 1.75 ft. Construction as attached detail. Complete with mounting saddles. Price...\$1433.00 ea.....	\$4299.00 Net Total
1.a	3 only	Armstrong WS 166-2 converters as above, but equipped with type B cast iron flanged heads. Price...\$1514.00 ea.....	\$4542.00 Net Total
2.	1 only	Armstrong series 1650, size 5030 duplex condensate receiver and pump set, complete with 24" diam. x 36" long receiver tank (72 USG). Pumps suitable for 50,000 sq. ft. EDR, 75 USGPM of condensate at 30psi. discharge pressure. Motors: 3 HP, 1750 RPM, 60/3/575. Includes float operated switch, interconnecting piping and common baseplate for pumps and tank. Price.....	\$1056.00 Net Total

EXHIBIT A5



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

REQUEST FOR QUOTATION

RFQ #7004-8

PROJECT #7004
City Hall, Hamilton

S. A. Armstrong Limited

February 17, 1970

TO: Smart-Turner-Hayward Limited

Canada Pumps Limited

ATTENTION:

Please submit in triplicate your quotation for the equipment or services as listed below. Quotations will be used for engineering estimates. Receipt of quotation would be appreciated before 12:00 Noon, February 19, 1970. Include descriptive literature and overall dimensions of equipment that you propose to supply.

Quote price including federal sales tax but excluding provincial tax.

Equipment

1. Hot Water Circulating Pumps

Two (2) only double suction centrifugal pumps, each to handle 500 U.S. GPM of 205 deg. F. hot water at 45 Ft. head, direct driven by a 1750 RPM, 575V, 60 cycle, 3 phase motor, sized for non-overloading conditions.

Project Co-ordinator,
C. Palmers:

QUOTATION

S. A. ARMSTRONG LIMITED

TELEPHONE 755-2291

1400 O'CONNOR DRIVE,
TORONTO 16, CANADATO: Quist and Associates Ltd.,
918 Main St. East,
Hamilton, Ontario.

GENTLEMEN:

PLEASE REFER TO
THIS QUOTATION NUMBER
WHEN ORDERINGQUOTATION **Burlington**
NO.

PAGE 1.

DATE Feb. 19, 1970

ATTENTION: Mr. D. Dickie
SUBJECT: RFQ-7004-8
City of Hamilton

In keeping with your request, we are pleased to quote you on the undermentioned items, subject to Terms and Conditions stated on the face and reverse side of the signature page of this quotation.

FEDERAL SALES TAX - **12% Included**PROVINCIAL SALES TAX - **Extra**

TERMS -

ON APPROVED CREDIT RATING

F.O.B. Toronto, with freight allowance included to Hamilton.

SHIPMENT: Subject to contingencies, we would expect to make shipment
your Order and settlement of all details.**as arranged**

after receipt of

PRICES ARE SUBJECT TO ADJUSTMENT to comply with the Company's price in effect at date of shipment.
REFER TO TERMS AND CONDITIONS ON REVERSE SIDE.

We appreciate the opportunity you have given us to quote on your requirements and we hope that our quotation will merit your approval. You may be assured that your Order will receive our best attention.

Should the information we have given you be insufficient, further details will be furnished on your request.



S. A. ARMSTRONG LIMITED

Per:-

Richard J. Fahey
Richard J. Fahey,
Hamilton - Niagara Repres.

Pumps • Hydronic Specialties • Heat Exchangers • Water Systems • Refrigeration Vessels

ITEM	QUANTITY	DESCRIPTION	PRICE
1.	2 only	<p>Armstrong series 4600, size 4"E horizontal split case double suction centrifugal pumps. Capacity: 500 USGPM each at 45 ft. T.D. Head. Suction - 5" flgd., discharge 4" flgd.</p> <p>Motors: 10 HP, 60/3/575, 1750 RPM, open protected encl.</p> <p>Pumps complete with casing and impeller wearing rings coupler guards and cast iron base plates.</p> <p>Price... \$1210.00 ea..... \$2420.00 Net Total.</p> <p>Further specification detail attached.</p>	

EXHIBIT A6



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

REQUEST FOR QUOTATION

PROJECT #7004

RFQ #7004-2

TO: Smart-Turner-Hayward Limited
Canada Pumps Limited

February 10, 1970

ATTENTION:

Please submit in triplicate your quotation for the equipment or services as listed below. Quotations will be used for engineering estimates. Receipt of quotation would be appreciated before 12:00 Noon, February 16th, 1970. Include descriptive literature and overall dimensions of equipment that you propose to supply.

Quote price including federal sales tax but excluding provincial tax.

Equipment

Three (3) in quantity pumps.

Service: Hot Condensate

Capacity: ~~40~~⁷⁰ US GPM @ 60 Ft. Head

To be complete with motor sized adequately for non-overloading at all points of pump curve.

REVISED TO 70 US GPM. FEBR. 16 70.
DO.

Project Co-ordinator:

A 6



SMART TURNER HAYWARD LTD PUMPS

2175 SHEPPARD AVENUE EAST, TORONTO, CANADA . TELEPHONE 449-0990 (AREA 416)

WILLOWDALE

February 13th 1970.

K. R. Archer

T-160-70

Quist & Associates Limited,
918 Main Street East,
Hamilton 22, Ontario.

Attention: Mr. Dave Dickie.

Subject: Project No. 7004.-2

Gentlemen:

Thank you for your enquiry dated February 10th 1970,
and we are pleased to submit the following quotation
for your consideration.

Service:

Fluid	:	Condensate
Suction	:	Flooded
Capacity	:	1040 USGPM
Total Head	:	60 ft.

Recommendation:

THREE Smart Turner Hayward, Model 1 GBUE,
horizontal, End Suction, centrifugal pump, with 1½" suction and 1"
discharge, ASA flanged connections.

Pump will be constructed with cast
iron casing, bronze enclosed impeller,
bronze shaft sleeve, steel shaft,
packed stuffing box and heavy duty,
grease lubricated, ball bearings.

.....

2



(3)

Pump will be driven through a pin
and rubber buffer flexible coupling
with guard, by a $\frac{1}{2}$ h.p., 3500 RPM,
3/60/550 volt, drip proof motor, all
mounted on a rigid steel base.

PRICE: (Pump, base, coupling, 291.00,
guard and motor complete).....\$281.00 ea. net.

EXTRA: (For supplying cast iron
baseplate).....\$ 50.00 ea. net.

Alternative:

✓ DUE

THREE Smart Turner Hayward, Model 1½ GBUE,
horizontal, End Suction, centrifugal pump, with 2" suction and 1½"
discharge, ASA flanged connections.

Pump will be constructed exactly as
described for Model 1 GBUE above,
but will be driven by 3 h.p., 1750
RPM, drip proof motor.

PRICE: (Pump, base, coupling, 363,
guard and motor).....\$~~363~~ 00 ea. net.

EXTRA: (For supplying cast iron
base).....\$ 50.00 ea. net.

Prices quoted are subject to the following conditions:-

F.O.B. Hamilton, Ontario,
All Sales Taxes Extra
Terms: Net 30 days
Delivery: 4 to 6 weeks.

We trust the above and the enclosed data provide you with
sufficient information to evaluate our quotation, but if
this is not the case, please do not hesitate to contact us.

Yours very truly,

SMART TURNER HAYWARD LIMITED.

K.R. Archer

K. R. Archer, P. Eng.
Sales Engineer.

mg.
Encl.

A6

EXHIBIT B1

R. C. MONAGHAN
B.A.Sc., M.E.I.C., P.Eng.
CO-ORDINATOR



YOUR FILE NO.

THE CORPORATION OF THE CITY OF HAMILTON

OFFICE OF CO-ORDINATOR
CIVIC SQUARE DEVELOPMENT

16 February, 1970.

Quist & Associates Limited,
Consulting Professional Engineers,
918 Main Street East,
Hamilton 22, Ontario.

Att: Mr. J. E. Quist,
General Manager.

Dear Mr. Quist:
Re: Civic Square - Heating
Study for Theatre Auditorium.

Enclosed for your information is a copy of a letter dated 20 January, 1970 from the Air Management Branch of the Department of Energy and Resources Management.

As discussed with you, the City wishes your report on the feasibility study of providing heating and cooling services to the proposed Theatre-Auditorium from the existing City Hall plant to include recommendations to overcome the problem outlined in Mr. Chrystman's letter.

Yours very truly,

Co-ordinator.

RCM:jw
Encl.

- c. c. Mr. K. E. Avery, Secretary,
Property and Licence Committee.
- c. c. Mr. Eric Hall, Interim Manager,
Theatre-Auditorium.

		QUIST & ASSOCIATES LIMITED		
PROJECT		7004	RECEIVED	
		FEB 16 1970		
JEQ	/	<i>[Signature]</i>		
CP	/			
THE				

B1

*copy to
Information
for*
Area Code 416
525-7910



970

DEPARTMENT OF ENERGY AND RESOURCES MANAGEMENT

Air Management Branch
554 Main Street East
Hamilton 22, Ontario
January 20, 1970

The Corporation of the
City of Hamilton
City Hall
71 Main Street West
Hamilton, Ontario

Mr. E. A. Simpson
City Clerk

Dear Sir;

QUEST & ASSOCIATES LIMITED

PROJECT 1800

FFA 10

DO	C	S	RLL		
CP	C		DD		
THE					

This is to confirm our meeting on January 16, 1970, at which you were advised that the emissions from the City Hall boiler plant stacks are in violation of the Air Pollution Control Act 1967.

An Engineering survey of the plant and effluent evaluation indicates that the impingement concentrations of sulphur dioxide at ground level and on nearby buildings, exceed the limits allowed in Table I of Ontario Regulation 449/67.

In addition to this, there is quite a definite fallout of soot and acid smuts. The latter is quite corrosive in nature and may cause damage to automobile and real estate paint finishes.

You are, therefore, advised to review the operation of your boiler plant and make the necessary changes in order to bring its operation into compliance with the current Regulation.

Would you kindly advise us not later than April 1, 1970, what corrective action you propose to take.

We shall be happy to meet with your consulting engineer and advise him on the technical aspects of the requirements.

Yours very truly

J. Chrystman, P. Eng.
District Engineer

JC:bc
Encl:Act 1967
O.Reg. 449/67

EXHIBIT B2



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

February 19, 1970

Fuel Applications Limited,
150 Canada Street,
Hamilton, Ontario.

Attention: Mr. Ron Zabrok

Re: Hamilton City Hall Boiler Plant, Conversion
to Gas-Oil Firing, Our Project No. 7004.

Dear Sir:

Confirming your verbal quotation received today by our Mr. D. Dickie,
in response to our letter dated February 19, 1970.

A) To Convert No. 1 and 2 Boilers and Gas Piping

2 - F14GO50 FP E2FT Burners (Gordon-Piatt)

60' - 3" Welded Pipe

30' - 2" Piping to Burners

Piping at Burners

Wiring

Removal of Existing Windboxes

3 - Gas Pressure Regulators

Venting of Regulators

3 - Barometric Draft Controllers

Remove Existing Burners

Install New Burners

Continued...

Refractory Repairs on Front Plate Only

3 - Hi-Gas Switches

Painting of Gas Lines Yellow

Painting of Front Plates Aluminum

B) Additional Work for Boiler No. 4

1 - 2-1/2" Automatic Safety Valve

1 - 2" LPC Main Gas Cock

Piping of Control Train

Wiring of Control Train

1 - Secondary Regulator

C) Modifications to existing oil piping and provision of duplex filters at each boiler.

TOTAL PRICE \$20,000.00

The above prices does not include cleaning of existing underground oil tanks, oil piping and transfer pumps.

Yours truly,



C. Palmers, Eng. Tech.,
Project Co-ordinator.

CP:at

EXHIBIT B 3

QUIST & ASSOCIATES LIMITED		UNITED GAS LIMITED		
		HAMILTON-ONTARIO		
RECEIVED..... 7064				
MAR 4				
JEQ	✓	PLL		
CP	✓	DP	✓	DP
FILE				

Mr. Dave Dickey,
 Quist & Associates,
 918 Main Street E.,
 Hamilton 22, Ontario.

March 4, 1970.

Subject: Natural Gas Conversion
City Hall, Hamilton, Ontario.

Dear Mr. Dickey:

As mentioned in my letter dated February 19, 1970, I am now submitting a second quotation supplied by The E. J. Walsh Company Ltd. regarding the conversion of the oil fired boilers.

We would recommend the installation of:

2 - only North American No. 6121-10.5 dual fuel burners

This burner shall be a fully modulating type on gas or oil with a forced low fire start and a 4 to 1 turn down ratio on both fuels. These burners will be of a nozzle-mix type with integral blower supplying 100% of the air for combustion and shall be hinged for easy accessibility to internals. A safety switch shall prevent burner operation when in open position. Burner shall have a maximum input rating of 10,000,000 BTU per hour and be equipped with adjustable potentiometer so that maximum input may be set at any capacity within the range of the burner.

A normal cycle of each burner will be a high fire prepurge, after which a proved spark ignited gas pilot shall provide ignition for a timed period of 15 seconds (on both gas and oil), and then the pilot will be automatically shut off allowing the combustion safeguard to monitor only the main flame. Burner will establish main flame at low fire only after which modulating controller shall adjust or modulate burner input to satisfy desired steam pressure. Upon shutdown the burner will have a postpurge.

Combustion safeguard shall be Minneapolis-Honeywell Model R4126A programming relay wired to provide quick fuel shutoff in the event of flame failure, air blower failure, low water level or excessive steam pressure. A MH C7012A Ultra-violet scanner shall be used to sense the gas pilot and main gas flame as well as main light oil flame.

cont'd....

B3

The burners shall be provided with a separate factory wired steel control cabinet of dust-proof construction housing control circuit fuse, blower motor starter, light oil magnetic starter, air compressor magnetic starter, atomizing air interlocking switch, combustion programming safeguard chassis, manual purge switch, fuel selector switch, manual high fire potentiometer control, on-off switch, terminal strips and pilot lights indicating "Limits", "Pilot", "Gas", "Oil", "Low Water", and "Flame Failure".

The burners shall be equipped with an oil pump set which operates only when firing with light oil. Burners shall utilize compressed air for oil atomization and each shall be furnished with its own compressor set which operates only when burning oil. Burners shall operate on either fuel by means of a fuel selector switch without any changes or alterations to the burner equipment. Burners shall be of such design that no main fuel lines need be broken when swinging open or gaining access to burner internals for servicing or maintenance. A large burner observation port shall be provided so that pilot flame, main flame and burner internals can be observed by operator.

Burners shall bear Ontario Hydro and Department of Energy Resources label.

Burner Control

ALL CHANGES NOTED BELOW VERIFIED WITH E.J. WALSH CO. LTD.

MARCH 4 /70 D.D.

All burner controls shall be 115 volt/single phase/60 cycle and each control panel shall include an integral mounted and wired 230 (or 460) 550 volt to 115 volt step down transformer (~~not required when blower voltage is 115 or 230/single phase/60 cycle or 208 volt/3 phase/60 cycle - four wire~~).
550 V. THREE

Blower motor shall be 5 h.p. Light oil pump motor shall be 1/2 h.p. and atomizing air compressor motor shall be 1 h.p. Voltage shall be 115 v. single phase. ALL ELECTRICAL WIRING WITHIN THIS CONTRACT
550 V. THREE

Operating, modulating and high limit (aquastats) (pressure controls) shall be furnished by the burner manufacturer for installation on the boiler.
INSTALLED WITHIN THIS CONTRACT

Installation

It would be our intention to remove the existing burner and supply a new front plate in place of the existing burner front plate casting. To this plate would be attached the North American burner complete with integral burner tile. The refractory would be made good around the front wall of the boiler where the burner is inserted. We would also remove the existing combustion air fan and cover the opening by means of a plate. No other changes to the tubes and/or present combustion chamber would be contemplated.

Upon completion of the installation the burner would be started up and adjusted for optimum firing conditions.

Gas Piping

The gas piping to the burners would be the responsibility of United Gas Ltd. We would supply the pounds to inches regulator required along with all necessary bleed lines from the regulator and gas valves.

cont'd...

B3

Oil Piping

It would be our intention to utilize the existing oil piping to and from the storage tank provided the storage tank was cleaned properly and the lines flushed out.

We would mount the oil pump and air compressor on the floor under the burner and pipe to and from the burner with properly sized piping and necessary shutoff valves.

The price for the two burners, installed as described above, would be \$18,382.50

Monthly Rental - \$275.75 plus Provincial Tax.

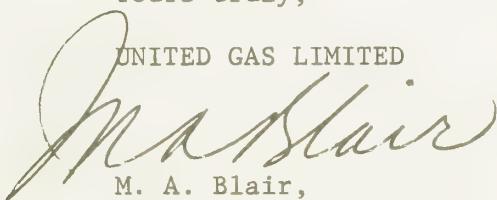
As on the other quotation, we will not be responsible for the service on any of the oil burners. Servicing of the oil portion of this equipment would be the responsibility of other than United Gas Ltd.

If you decide to rent this equipment, it would be necessary that a contract be signed with The City Of Hamilton guaranteeing the use of natural gas, and that number 2 oil only be fired as an emergency measure.

We are enclosing descriptive literature on the burners quoted. If you have any questions do not hesitate to contact us.

Yours truly,

UNITED GAS LIMITED



M. A. Blair,
Supervisor,
Commercial GAS Sales.

MAB/cjp
Encls:

EXHIBIT B4



J. E. QUIST, B.A.Sc., P.Eng.
C. PALMERS, Eng. Tech.
R. L. LEIGHTON, M.Sc., P.Eng.

918 MAIN STREET EAST
HAMILTON 22, ONTARIO
TELEPHONE 547-0183

REQUEST FOR QUOTATION

RFQ #7004-3A

PROJECT #7004
City Hall, Hamilton

February 12, 1970

TO: Waterloo Manufacturing Co. Ltd.

ATTENTION:

Please submit in triplicate your quotation for the equipment or services as listed below. Quotations will be used for engineering estimates. Receipt of quotation would be appreciated before 12:00 Noon, February 16th, 1970. Include descriptive literature and overall dimensions of equipment that you propose to supply. Quote price including federal sales tax but excluding provincial tax.

Equipment

Two (2) only steam boilers ~~175~~²⁰⁰ BHP capable of producing ~~6000~~⁶⁹⁰⁰ lbs. of saturated steam at 12 psig.

Equipped for gas firing with #2 fuel oil as standby fuel.

Natural gas at 5 psi inlet pressure.

Include delivery charges to job site, 90 day service and initial start-up.

Project Co-ordinator
C. Palmers:

This replaces our request of February 10, 1970 for price on one 250 HP boiler.

PROPOSAL

Cleaver Brooks of Canada, Limited

STRATFORD, ONTARIO

Page ____ of ____ Pages

Quist & Associates Ltd.
918 Main St. E.
Hamilton 22, Ontario. Attn: Mr. C. Palmer
Address

Proposal No. 703-15

Date February 27/70

SUBJECT: Hamilton City Hall Your Reference No. From

Engr: Quist & Assoc.

TWO (2) Cleaver-Brooks boiler burner units as follows:

Type: four pass horizontal firetube

Model No.: CB200-200, Design 15# PSI

Ratings: 6900# steam per hr f/a 212°F. or 200 BHP

Fuel: natural gas & #2 oil

In accordance with specifications #C9-3116, C9-3314, C9-3118

Extras included beyond our standard specifications:

1. gas pressure regulator;
2. gas relief valve;
3. control circuit transformer mounted;
4. 1 yr warranty, startup, 90 days free service from date of startup.

Not included: installation.

NET PRICE: \$20,722.00

Fed. tax included (heating certificate required)

Prov. tax extra

NOTE: Heating Contractor commission
is included in price.

Shipping FOB Factory, freight Current Terms allowed on truck to curb jobsite	Characteristics	550/3/60	Approximate Shipping Weight
Payment Terms Net 30 days from date of shipment	of Order and Complete Details	Approximate Shipment after Receipt 8 weeks	

THE TERMS AND CONDITIONS OF SALE PRINTED ON THE REVERSE SIDE OF THIS SHEET, UNLESS EXPRESSLY EXCEPTED HEREIN, ARE PART OF THIS PROPOSAL.

THIS PROPOSAL IS SUBJECT TO CHANGE OR WITHDRAWAL WITHOUT NOTICE. PRICES QUOTED SHALL BE FIRM FOR THIRTY (30) DAYS FROM DATE OF PROPOSAL UNLESS OTHERWISE SPECIFIED. ANY EXTENSION OF TIME IS SUBJECT TO APPROVAL OF COMPANY. IF ACCEPTED BY THE PURCHASER IT SHALL BECOME A CONTRACT WHEN APPROVED BY AN AUTHORIZED COMPANY REPRESENTATIVE AND MAY THEN BE MODIFIED BY WRITTEN AGREEMENT ONLY. NO STATEMENTS OR UNDERSTANDINGS RELATING TO THE SUBJECT MATTER, OTHER THAN THOSE SET FORTH HEREIN, SHALL BE BINDING ON CLEAVER-BROOKS OF CANADA, LIMITED (HEREINAFTER REFERRED TO AS THE "COMPANY").

PROPOSAL FURNISHED BY:

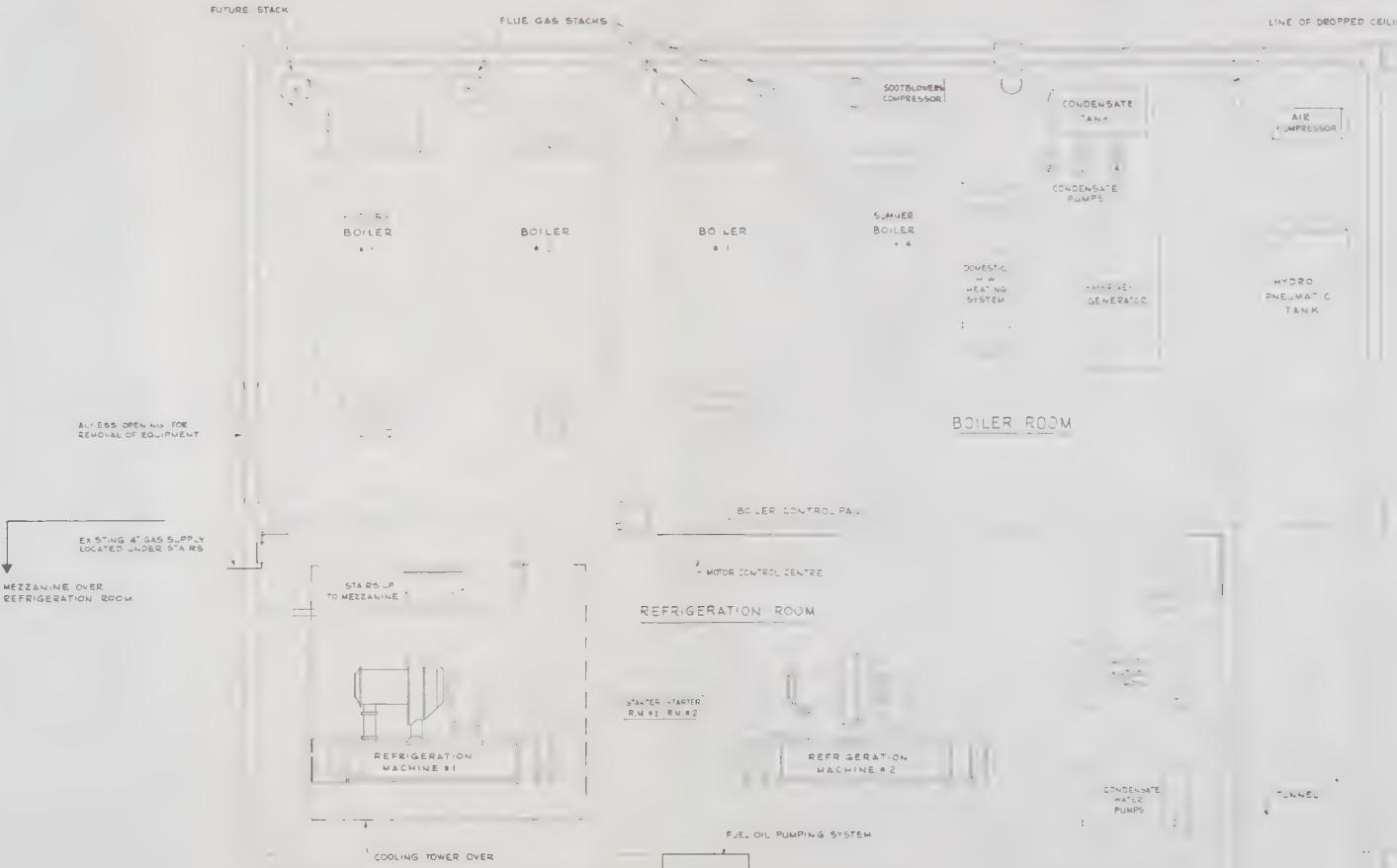
Waterloo Mfg. Co., Ltd.

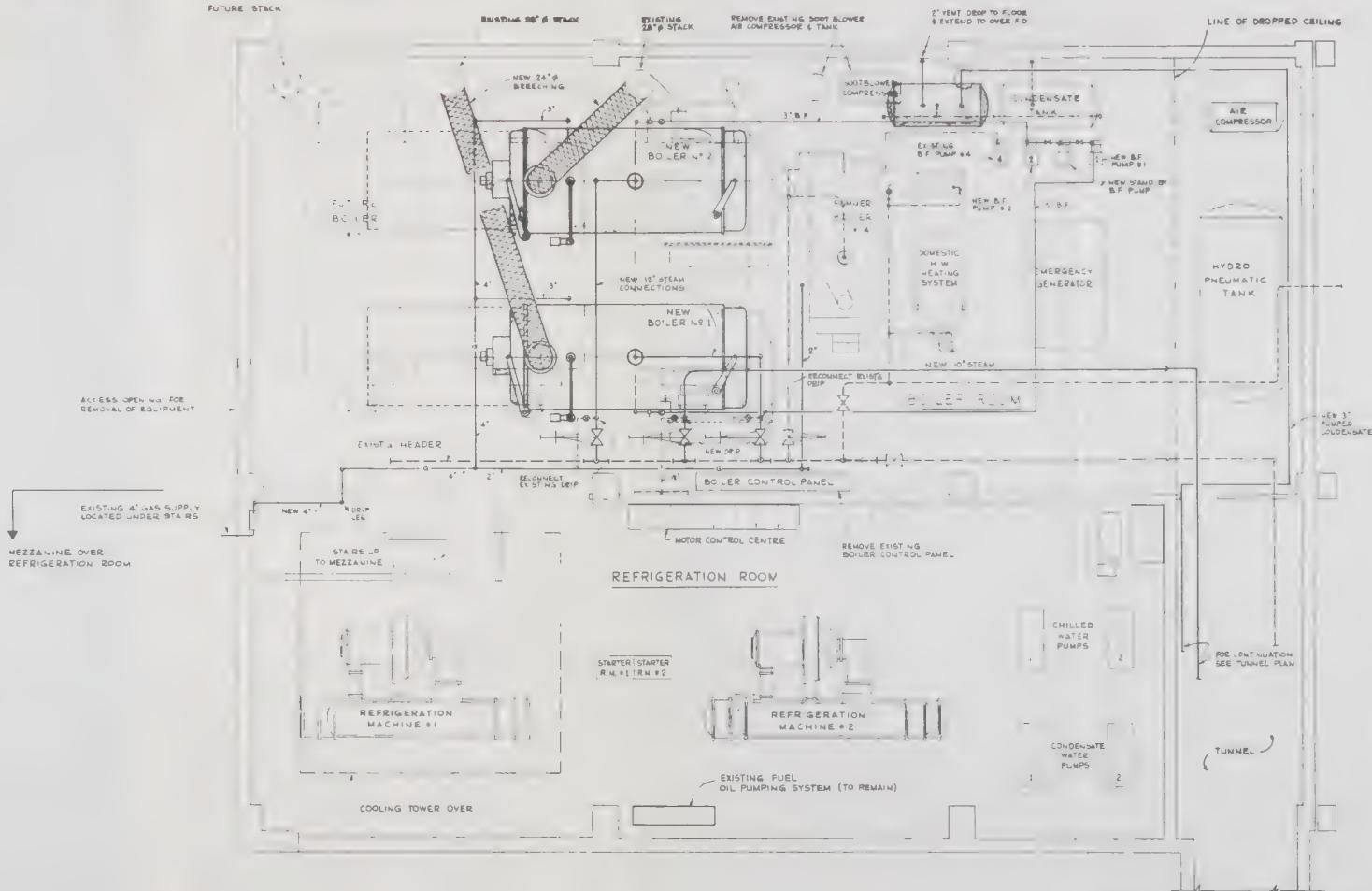
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Z. V. Z.

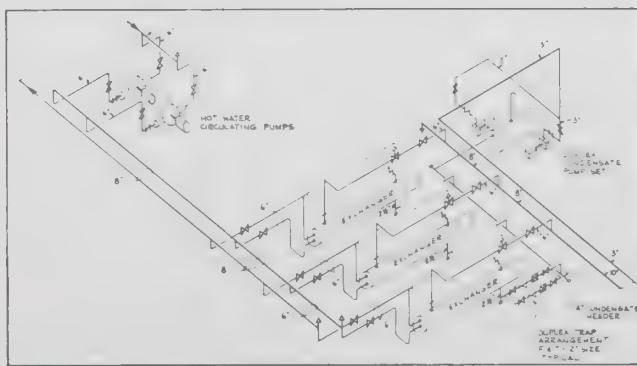
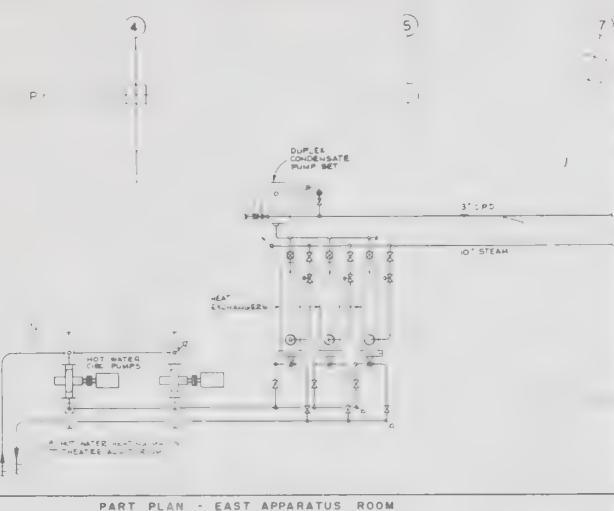
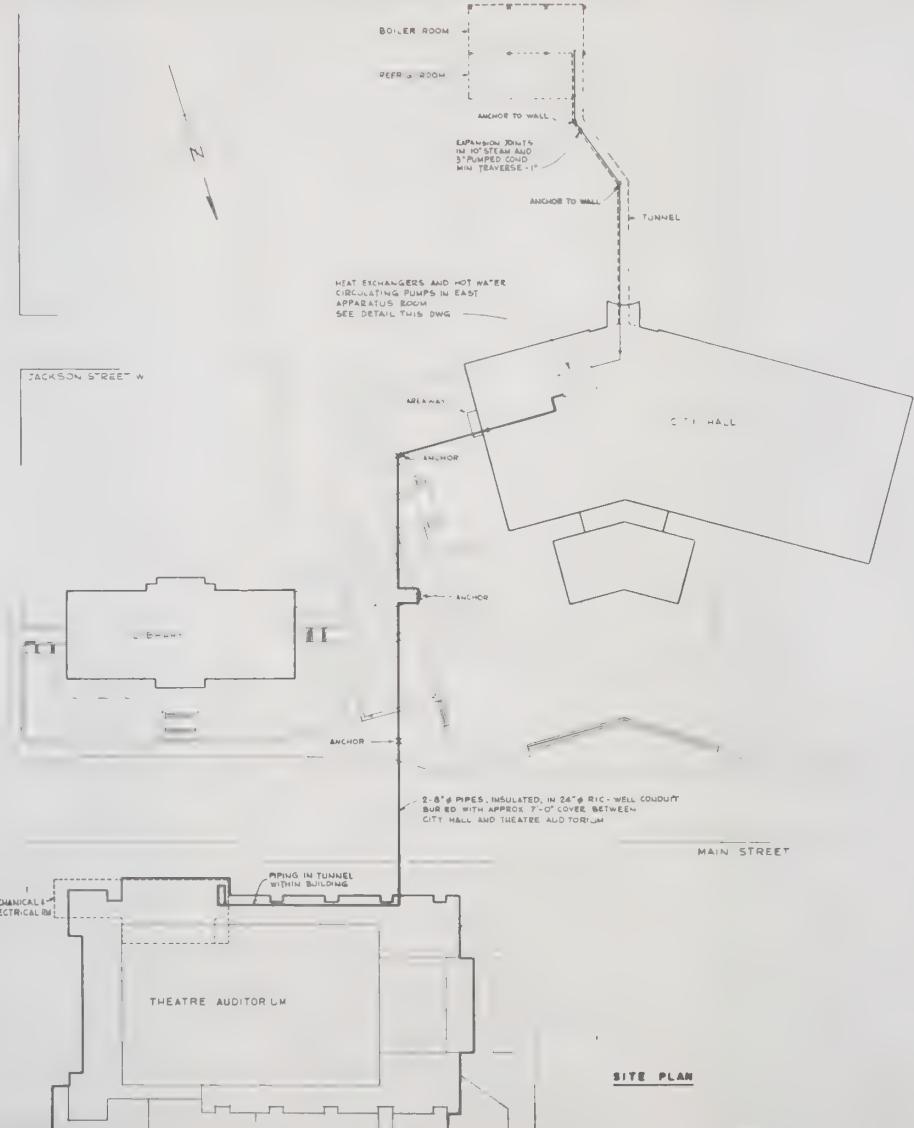
F. Gerth/bn

Date ACCEPTED 19.





QUIST & ASSOCIATES Consulting Engineers
LONDON, ONTARIO
PROJECT STUDY OF
CITY HALL PLANT
FACILITIES FOR HEATING & COOLING
THEATRE AUDITORIUM BUILDING
TITLE LAYOUT OF BOILER ROOM
CHANGES FOR LARGER BOILERS
A 2

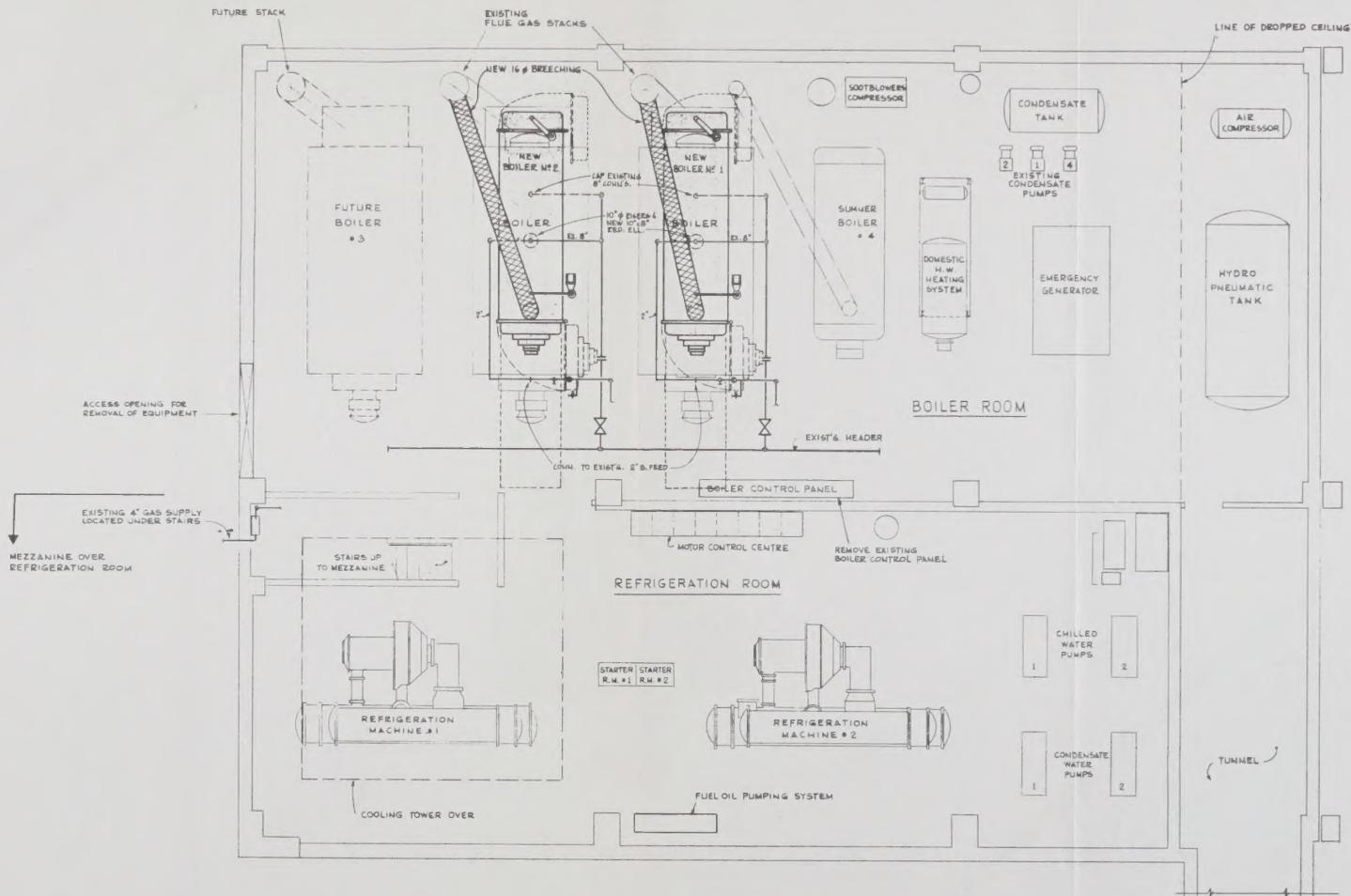


QUIST & ASSOCIATES consulting professional engineers
LTD. 1960 HAMILTON ONTARIO

PROJECT STUDY OF
CITY HALL PLANT
FACILITIES FOR HEATING & COOLING
THEATRE AUDITORIUM BUILDING

TITLE SITE PLAN &
LAYOUT OF EAST APPARATUS ROOM

A 3



**QUIST & ASSOCIATES consulting professional engineers
LIMITED CANADA TORONTO**

PROJECT: STUDY OF
CITY HALL PLANT
FACILITIES FOR HEATING & COOLING
THEATRE AUDITORIUM BUILDING

TITLE: LAYOUT OF BOILER ROOM
CHANGES FOR SCHEME NO.2

B1

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